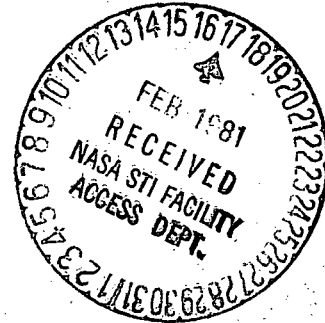


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C.

Voyager Saturn Encounter Press Briefing

October 28, 1980



Participants:

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MR. PANAGAKOS: Good morning. I am Nick Panagakos the Public Affairs Officer for Space Science and this is a news briefing on the coming encounter of the Voyager 1 spacecraft with the planet Saturn.

The Voyager has been traveling in space since 1977 and has covered 1.3 billion miles since launched. This morning the spacecraft is 12,860,000 miles from the planet and is closing that gap at a speed of about 45,000 miles an hour relative to the Sun.

The close approach is going to occur on Nov. 12th, when the spacecraft comes within 77,000 miles of the planet and here today to discuss the Voyager 1 mission and the science are Andrew Stofan, who is Acting Associate Administrator for Space Science here at Headquarters; Dr. Edward Stone, who is the Voyager Project Scientist from the California Institute of Technology; Ray Heacock, Voyager Project Manager, the Jet Propulsion Laboratory; and Dr. Bradford Smith, who is Team Leader of the Voyager Imaging Team and he is from the University of Arizona.

We have also got others in the audience who will be available to answer questions later on and they include Angelo Guastaferrro, who acts as Director of Planetary Programs; Dr. Howard Robins, who is Planetary Operations Manager for NASA; Frank Carr is the Acting Voyager Program Manager; and Dr. Milton Mitz is the Program Scientist.

I think we also have available to us Gen. Charles H. Terhune, Jr., who is the Deputy Director of Jet Propulsion Laboratory is here today. Are you here, General? Yes in the back?

And Robert J. Parks who is JPL's Assistant Director for Flight Projects.

There is an information kit available in the back of the room for those of you who have not already got one and that includes a Voyager press kit and other material, and audio visual material that might be of interest to you.

There is a four-and-a-half-minute and a one-minute, for the TV people, video tape cassette available with a script and there is also a four-and-a-half-minute computer simulation film and a rotation film which you will see during the briefing. Both of these will be available to television and film people from Les Gaver, whose office is across the hall from this auditorium.

The proceedings are being transcribed and transcripts will be available in about a week. I remind you that if you are on our mailing list that you will get one automatically. If you are not, address a brown envelope again, those brown envelopes are in the back of the room, to yourself and we will see that you get a transcript.

There are three new photographs of Saturn that are available

today in color and black and white, and those are displayed on the table in the back. Those of you who are qualified media may have a copy of either one, again, from Les Gaver across the way.

This briefing is being piped to NASA centers: the Jet Propulsion Laboratory; Kennedy Space Center; the Johnson Space Center in Houston; the Marshall Space Center in Huntsville, Ala.; and Langley in Hampton, Va.

It is one way, but we will entertain questions from these centers later on if they are called into the newsroom and the participants will try to answer them.

We will begin now with Andrew Stofan. Andy?

STATEMENT OF ANDREW STOFAN, ACTING ASSOCIATE
ADMINISTRATOR FOR SPACE SCIENCE, NASA HEADQUARTERS

Mr. STOFAN: I would like to give just a very brief introduction and then get on with the status of the spacecraft and the science and some of the expectations for the mission. May I have the vugraph please?

(Slide.)

Mr. STOFAN: Voyager 1 was launched some 38 months ago on Sept. 5th of 1977 and the Voyager 2 on Aug. 20th of 1977. Could we dim the lights a little bit more so that they could see that?

Okay the two Voyager spacecraft were launched by the Titan Centaur launch vehicle and this mission then has a special dual meaning for me for in the 1977 time period I was the Director of Launch Vehicles at the Lewis Research Center and was responsible for the launch of the two Voyager spacecraft.

Now I happen to be fortunate enough to be the Acting Associate Administrator of the Office of Space Science when the two spacecraft will have their encounter with the planet Saturn, thereby achieving their primary mission function. So this is a double delight for me.

The Voyager 1 spacecraft encountered Jupiter in March of 1979. It will continue on with its encounter with Saturn on Nov. 12th and then head out of the solar system, about 35 degrees to the ecliptic plain.

The Voyager 2 spacecraft encountered Jupiter last July. It will encounter Saturn on August of next year. Thereafter it will travel on to Uranus and have an encounter there in January of 1986 and then possibly on to Neptune for an August of 1989 encounter.

The status, the detailed status of the spacecraft will be presented by Mr. Ray Heacock, the JPL Voyager Project Manager.

Ray?

STATEMENT OF RAY HEACOCK, VOYAGER PROJECT MANAGER
JET PROPULSION LABORATORY

MR. HEACOCK: Good morning. I am pleased to be able to give you an update of the Voyager program. We believe we are in excellent shape to achieve the equivalent scientific results to Saturn to what we achieved last year to Jupiter.

What I would like to do this morning is give you a brief overview of the trajectory -- and the first slide please.

(Slide.)

MR. HEACOCK: As already indicated, we had our encounter with Jupiter last year and will, on Nov. the 12th, make our closest approach to Saturn and then proceed deflected out on up to the plane of the ecliptic on out of the solar system into outer space.

The Voyager 2 spacecraft is functioning well and we have a very quiet cruise sequence load stored on board the spacecraft in order to keep it functioning at a low level during the time that we are actively involved with the Voyager 1 spacecraft and would prefer not to have to divert our attention over to Voyager 2. So that the Voyager 2 will go through this quiet period of still approaching Saturn, of course, because it is still 283 million kilometers away and will make its encounter on Aug. the 25th and then proceed on towards Uranus and Neptune.

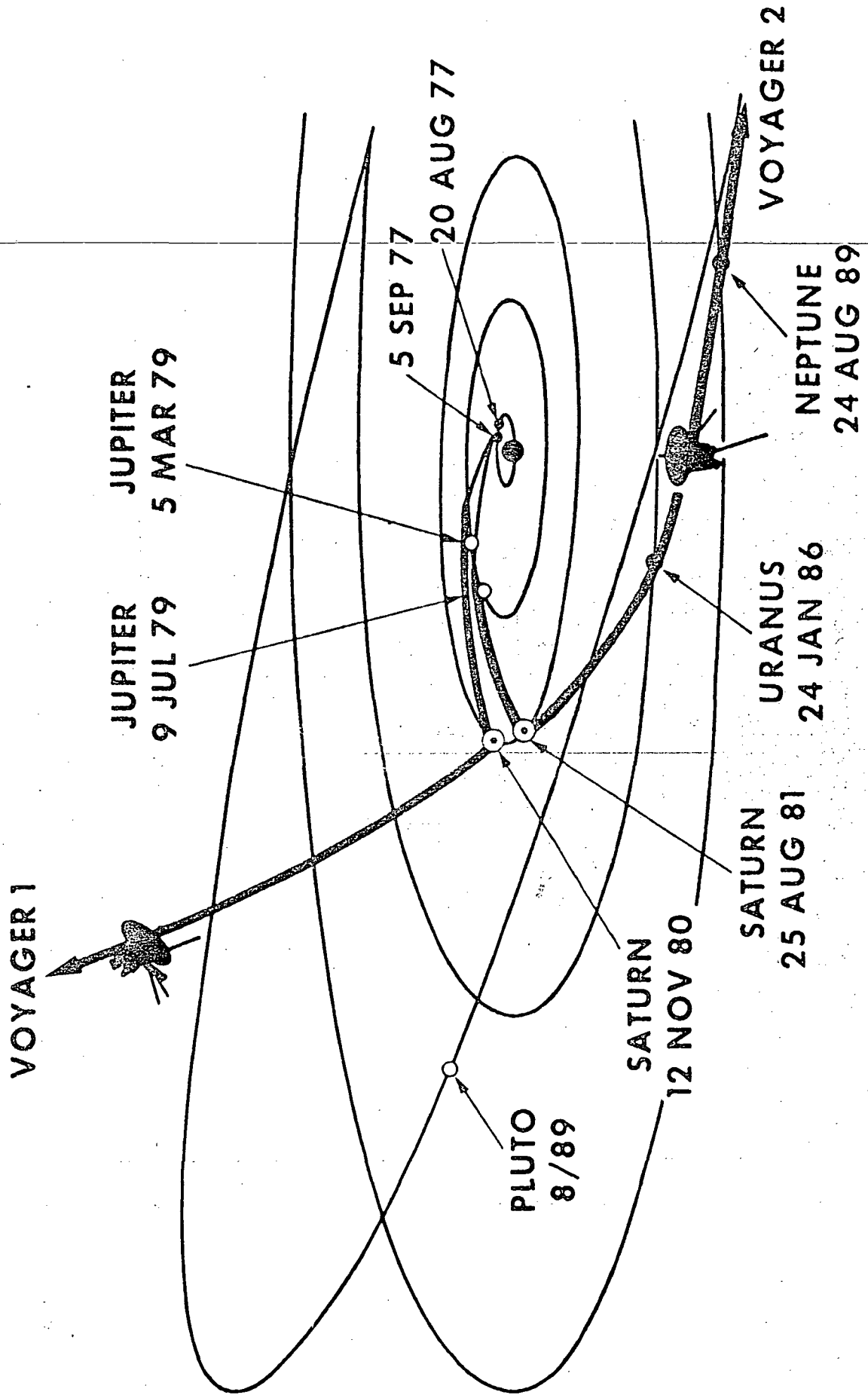
And the reserves, in terms of full power margins, everything, are in very good shape for Voyager 2, so I think we can put that one out of our minds until next year when we come up on our encounter with Saturn with it.

In the case of Voyager 1, let me use the next vugraph to go through our overall status with that spacecraft.

(Slide.)

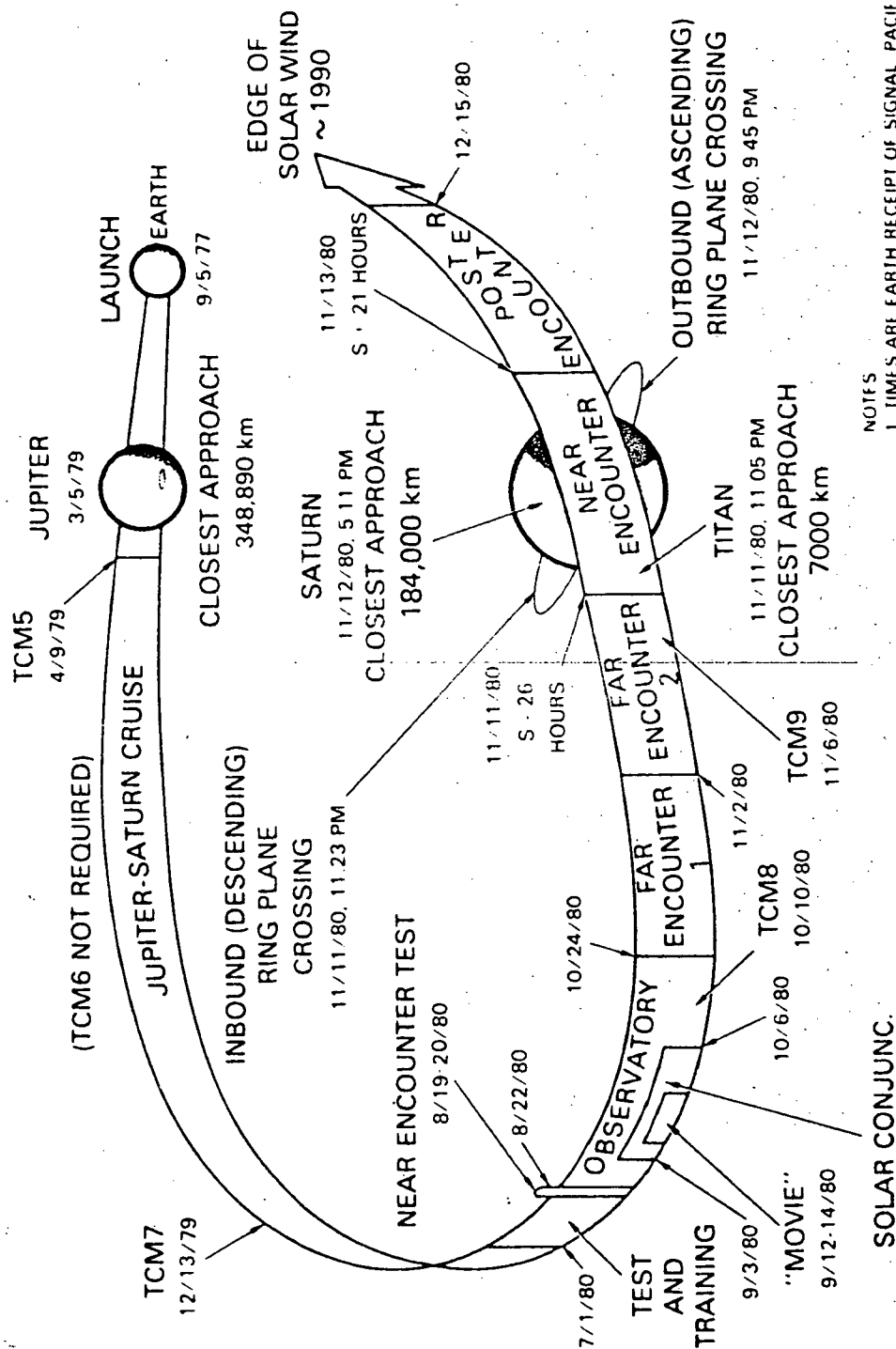
MR. HEACOCK: We performed a trajectory correction maneuver on Dec. the 13th, which brought us into a very good relationship with Saturn in our encounter and we then trimmed that up on Oct. the 10th, TCM number 8, and we now have a trajectory which is within a couple of hundred kilometers of our endpoint and, of course, we will have to continue to track the spacecraft and we find that target position from the standpoint of trajectory path, and also from the standpoint of the positions of Titan and Saturn in relationship to that trajectory path.

If it is necessary we have a trajectory correction maneuver in our schedule planned for Nov. the 6th in order to make whatever final corrections would be required.





VOYAGER 1 SATURN ENCOUNTER STATUS REPORT SATURN ENCOUNTER PHASES OVERVIEW



- NOTES
1. TIMES ARE EARTH RECEIPT OF SIGNAL PACIFIC STANDARD TIME
 2. DATES ARE GREGORIAN CALENDAR
 3. DISTANCES ARE FROM CENTER OF BODIES
 4. ONE WAY LIGHT TIME - 1 HR 24 MIN 47 SEC AT SATURN CLOSEST APPROACH
 5. TCM TRAJECTORY CORRECTION MANEUVER

RLH-5
10/27/80

Now we have, of course, since the Jupiter encounter, been working on the design of the sequences that will be required to carry out the scientific observations that are desired by our science team for the Saturn encounter.

All of the effort that was done before we started encounter phase was completed on schedule and we are currently in the last cycle of updating those sequences and bringing in the last set of changes that are desired by the scientists for the encounter.

And that is all going on schedule and is in excellent shape.

The training phase was carried out from July the 1st up until August the 19th and 20th when we did a near encounter test simulating the most complex encounter sequence with the spacecraft and having it executed to demonstrate not only its readiness, but also the readiness of our entire operations and organization.

We began the observatory phase on August the 22nd and have now completed it. Friday, Oct. 24th was the last of the observatory phase sequence execution and we are now in far encounter one where we are now close enough that we have to use two-by-two mosaics in order to image the entire planetary ring system.

The spacecraft's health is generally very good. We, of course, lost the photopolarimeter experiment during the Jupiter encounter, so that instrument is turned off. However, all of the other science instruments are in excellent shape and we expect to get good science return from all of them.

The spacecraft itself, we have one difficulty. We have experienced some problem with the Canopus star tracker. There is a degradation of an insulating sleeve on the input lead of a transistor. It was rather difficult to figure out that that is what was wrong, but that is the best model of the problem that we see.

This leakage affects the positioning of the star tracker aperture in one axis and it restricts somewhat then the available stars that can be used during the encounter phase. However, we have investigated probably very thoroughly, modeled the difficulties and verified that we can acquire and lock onto with adequate sensitivity all of the stars required for the Saturn encounter. And those are Canopus up until the time of Titan encounter, at which point we go to the star Miaplacidis. After the Saturn closest approach we shift over to the star Aldena and then shortly after that to the star we will use for the close encounter leg on out through the rest of the encounter phase, which is Vega.

And the tracker does not change its performance characteristics and it has not changed at all since April 30th of this year. So the failure, this leakage is very stable. Then we can acquire all of the stars that are required.

In addition, we have implemented a software patch in the spacecraft, which merely has to be linked in order to bring the backup Canopus tracker into play and as a substitute for the existing tracker.

We have not chosen to do that ahead of a real need because we get better accuracy and overall system performance out of the current tracker despite this insulating sleeve problem.

I want to assure you that the system performance is excellent and we are getting our planned observation without any compromise whatsoever.

Now in the case of the encounter phases, as I said, we are in encounter one. On November the 2nd we will move to far encounter two where we will primarily concentrate on regional two-by-two mosaics and then on November the 11th we will transit into the near encounter phase with the Titan encounter following shortly thereafter and on November the 13th move to the close encounter phase where we will be receiving from Saturn, above the plane of the ecliptic with the excellent view of the system.

We are going to take about 18,000 photographs through the entire encounter phase, which is I think a little more than Voyager 1 took in the Jupiter encounter.

(Slide.)

MR. HEACOCK: Now the next slide shows the near encounter trajectory and I would like to go through this very quickly. I have a computer animation movie which essentially starts with a view of the Saturn system from about 16 million kilometers above the system, looking down and you will see the orbits of the satellites and the flight path of the spacecraft much as it is shown on this vugraph.

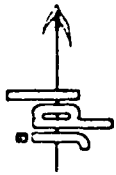
And then we will move in along the flight path of the spacecraft and then fly with the spacecraft through the Saturn system.

(Slide.)

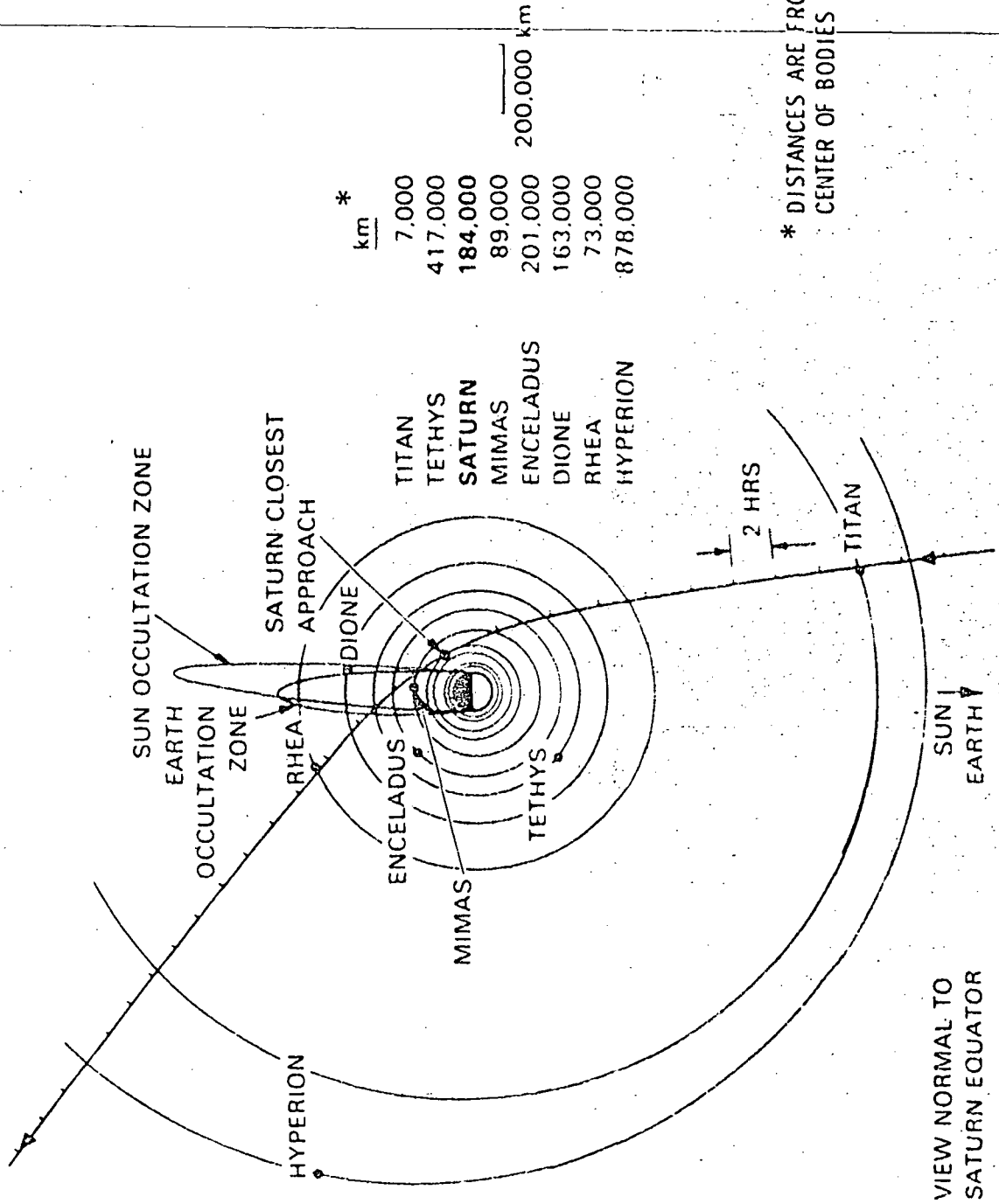
MR. HEACOCK: I would like to comment on this very briefly. In the case of the encounter with Saturn the magnetosphere is about a third of that of Jupiter's and the boundary may be in the vicinity of Titan, inboard, outboard, depending upon what the solar periphery is.

We make a very close flyby atop of Titan. The distance is quoted here. The distance is from the center, so in fact it will only be about 4,500 kilometers above the surface of Titan.

We will have Sun and Earth occultation. We will go through the ring plane shortly, although while we are in occultation then we will be below the plane of the satellites and the rings until



VOYAGER 1 SATURN ENCOUNTER STATUS REPORT NEAR ENCOUNTER TRAJECTORY



we complete the closest approach and then we will be deflected up out of the plane and we will exit the ring plane at about the orbit Dione into what we call Dione clear zone.

We will pass above Rhea, be able to get excellent images of Rhea. In fact, in order to improve the resolution by about a factor of 10, while we take one set of mosaics of Rhea we will actually move the spacecraft to compensate for the relative motion between the two bodies that we can get about a two-kilometer or slightly better resolution of the Rhea surface. And then, of course, proceed on out of the Saturn system.

Now I would like to move to the movie at this point then.

Here we are above the system with the satellite orbits, moving it along the trajectory to about the 1.6 million kilometers. You can see Titan there and then as we proceed in to our closest approach with Titan -- I can't tell -- that still looks slightly out of focus. That is better -- no, went too far.

We will try that again. I might comment that James Blinn and Charles Kohlase, who were the architects for this film have really done a fantastic job.

They have added articulation to the scan platform. And when you realize that everything you see there is merely a series of numbers created by them at their computer, it is really quite fantastic that they have been able to provide this kind of an animation.

Here we are coming in for a close encounter with Titan and, of course, we have Sun and Earth occultation. There is the Sun and the Earth. And we would have gone through the ring plane at about that point. Now we shift our view back to Saturn.

We are below the ring plane. You can see the ring relative to shadow on the planet. Pretty soon here we will shift our frame of reference over to view Tethys. The view at this point will be equivalent to the narrow angle camera's field of view and Tethys is about 540,000 kilometers away.

That is about our best view of Tethys. Next we come back to Saturn for a close flyby to Saturn. As you can see we are swinging down towards the southern pole. And our perspective in terms of photography ought to be just fantastic.

Bring out number two please. Okay, this is Mimas, angle with the narrow angle camera field of view. We are obviously quite a bit closer there. And here is the Sun exiting occultation. The Earth exited through the ring gap and then, of course, both proceeded across the ring. There was the E ring, which we know now does exist, but since we are exiting through the Dione clear zone we do not think that there is any significant hazard to the spacecraft.

This is the view of Rhea. As I said, we are passing above Rhea and we would take our best photographs with image motion compensation of the entire spacecraft moving in a counter direction to the relative motion of the two bodies.

~~That was a role of the spacecraft to provide a different~~
referencing into the star and in order to provide fields and particles data.

You can see our view of Saturn and the ring system with the shadow of the planet on the rings that ought to provide some spectacular coverage.

Soon we will move over to a view of Titan from about 2.3 million kilometers and see the crescent with the Titan.

Next we will come back to a view of Saturn and the spacecraft and the spacecraft is going to execute a fields and particles maneuver involving a series of roll and yaw turns in order to be able to span out the various fields and particles data and then re-establish itself on Vega and, of course, the platform then articulated itself to look out over Iapetus and we will be able to view Iapetus from about 1.6 million kilometers and we will get an excellent coverage of it.

The platform is back to view Saturn as we exit the system. And, of course, the post encounter phase ends on December the 15th.

Next I would like to introduce Dr. Ed Stone, the Voyager Project Scientist, who will give you an overview on solar science expectations.

STATEMENT OF DR. EDWARD STONE, VOYAGER PROJECT SCIENTIST
CALIFORNIA INSTITUTE OF TECHNOLOGY

DR. STONE: Well, this morning what I would like to do is give you some idea of the things that we will be looking forward to in the next two weeks and then turn the program over to Brad Smith who will tell you some of the things that, in fact, we have already learned during the observatory phase. If I could have the first slide please.

(Slide.)

DR. STONE: Just to remind you that, in fact, there are 11 scientific investigations on the spacecraft. These are the principal investigators, team leaders on the investigations. There are over 100 scientists around the country who are presently working on the Voyager program.

These instruments, of course, are remote sensing instruments. The photopolarimetry experiment, as Ray said, is not working on the Voyager 1, but is working on Voyager 2. These are

instruments which share the scan platform and view the planets, the planet, the satellite and the Saturnian system.

This, of course, is the experiment that uses the spacecraft radio transmitter to probe the various atmospheres and the rings, in this case, and these are the investigations which are looking at the particles and fields environment of the Saturnian system.

There are four major -- if I could have the next slide please.

(Slide.)

DR. STONE: There are four major areas which we are investigating at Saturn. One of them is the planet itself and this composite photograph, it is a scale, an image of Earth, an image of Saturn. Again, it emphasizes that Saturn is another giant planet. Oh, sorry, I want the first slide back.

(Slide.)

DR. STONE: This is a giant planet just as Jupiter. It is a bit smaller than Jupiter, but still large compared to the Earth.

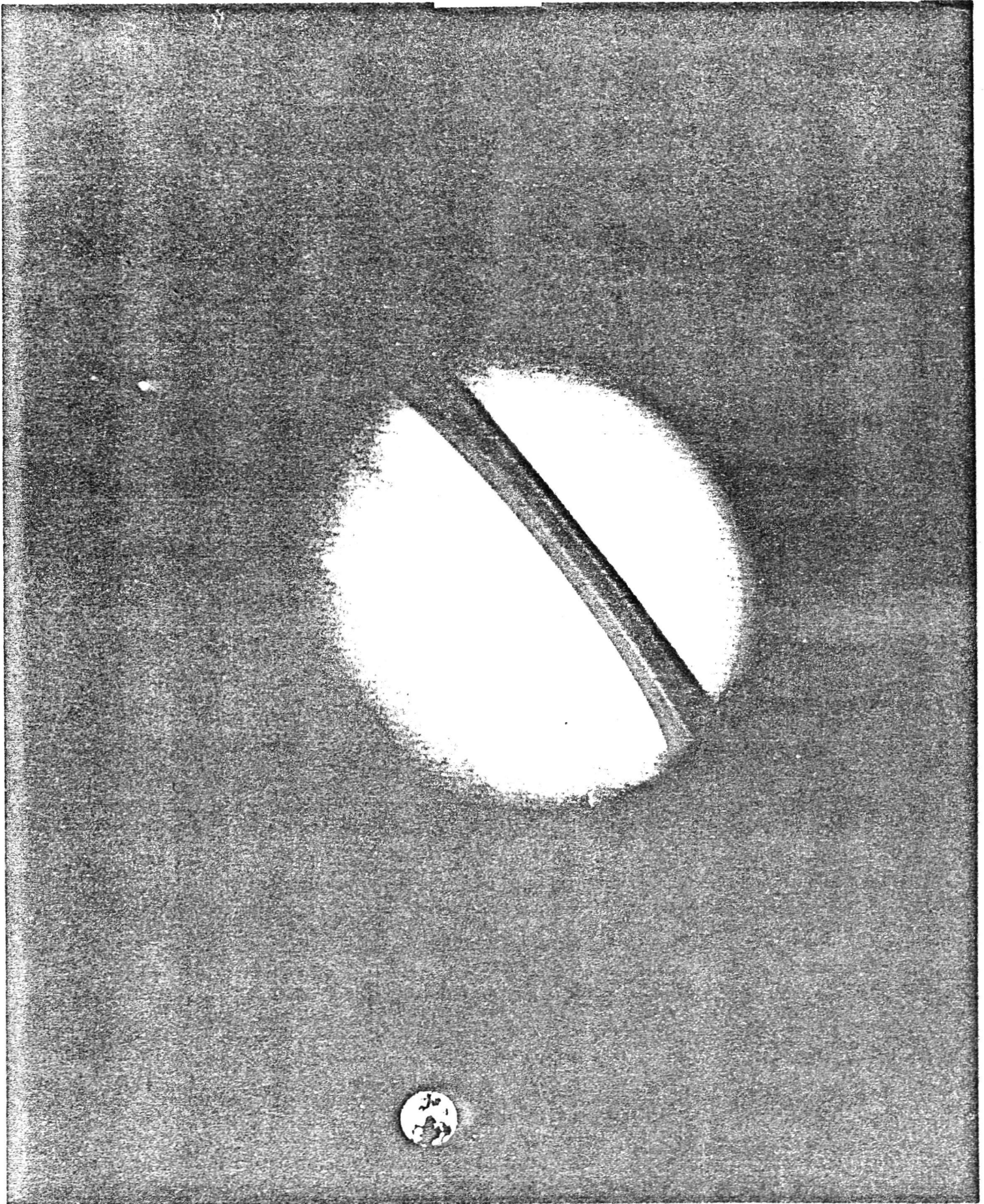
We now believe based on Pioneer 11 flyby results that indeed there is a rocky core about the size of the Earth, but some 15 to 20 times as massive and that the rest of what we are looking at is, as at Jupiter, an input of mainly hydrogen and with about 10 percent helium and then a lot of other trace constituents. And the clouds, of course, are just the things that we see at the top of this very deep atmosphere.

Now, one very obvious difference is that there is the -- the contrast is not nearly as sharp on Saturn and one explanation for that is that Saturn, being twice as far from the Sun, has effectively a lower temperature. The effective temperature at Jupiter was about -- at Saturn is about minus 290 Fahrenheit, at Saturn it was about 60 degrees warmer.

What that means is that the clouds which one sees which form at a given temperature, to reach that same temperature on Saturn you must go deeper into the atmosphere and nearer the center of the planet. The net result is the clouds are much deeper and we are looking at a much thicker, hazier region and the contrast is not nearly as sharp as at Jupiter.

But as Brad will show, we are indeed seeing some interesting details.

The other things which we will be doing during our mission phase at Saturn, we will be measuring the temperatures very accurately in the complicated Belt Zone Structure which exists on Saturn, we will be looking at the amount of excess heat coming from Saturn which Pioneer told us was about twice, 2.8 times that



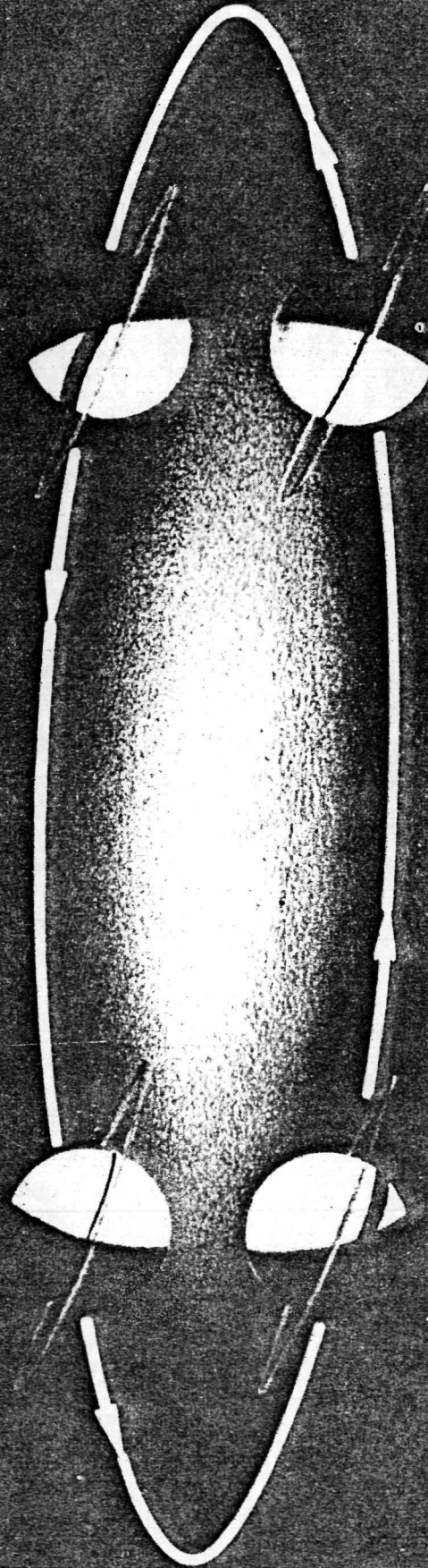
NORTHERN
SPRING
MARCH 1980

NORTHERN
WINTER
1973

NORTHERN
SUMMER
1987

NORTHERN
FALL
1986

ONE SATURN YEAR IS 29.5 EARTH YEARS



which Saturn absorbs from the Sun. So Saturn also has an internal heat source.

We will be measuring the composition of the atmosphere in some detail. Those are all things which, of course, are ahead of us in the next two weeks.

The second area that we are going to be looking at in some detail is the ring system around Saturn.

(Slide.)

DR. STONE: The next slide just gives us some perspective on how the rings, the lighting of the rings has changed over the Saturn year. The Saturn year is about 29 and a half Earth years.

The northern winter, in other words the equivalent of our December, occurred last in 1973. This last March we went through the equivalent, March 21st in the Earth year, in other words the spring equinox and we are now about equivalent to April 1st in an Earth year. In other words, we are just slowly approaching the northern summer which will happen in 1987.

So you see at the time of the Pioneer encounter the Sun was actually illuminating the southern side of the rings. We were just ending the southern summer and during the Voyager 1 encounter we are just beginning the northern spring.

As a result the rings are rather dimly lighted because the Sun is very near or just slightly north of the Saturnian equator.

(Slide.)

DR. STONE: The next slide illustrates the different viewing geometries which we will have on Voyager and, in fact, which Pioneer also had. Here is the sunlight now coming -- you could focus that a bit please. Here is, in cross section, the A ring, the B ring, and the very tenuous C ring of Saturn itself. Here is sunlight now coming just from slightly the northern side of the ring system.

If we view the ring system from the lighted side, what we see is light reflected from the A ring. We see no light reflected from what is called Cassini Division. We see a lot of light reflected from the B ring and a very, very diffuse amount of light deflected from the C ring.

If we view it from down here, which is where Pioneer viewed the rings predominantly, it was, of course, at that time the north side of the ring, and we will be viewing it during closest approach, what we see is light transmitted through the ring. We see the light from ring A. There is some material in the Cassini Division, enough to scatter light so that we can see it, none of the light, or very little of the light gets through ring B, and a

reasonable amount of light actually transmitted through the tenuous C ring.

So we will be seeing on Voyager both the lighted and the dark side of the rings and that provides a wealth of detail by comparing the two different profiles.

Brad will be showing you some recent ring results. I want to talk a little bit about some other things which we expect to do.

(Slide.)

DR. STONE: The next slide shows an example of some of the narrow angle fields of view laid down on the rings during our closest approach. This image is not correct in the sense that we will be viewing the dark side of the ring, so this will be a very dark area except where there are any holes in the rings.

The resolution in this particular time period will be about five kilometers per pixel. And so that gives you some idea of the size of structure which we should be able to image directly. In addition our infrared instrument will be used to measure the temperature of the particles in the rings as the particles go into eclipse, start cooling off, and then as they come out of the eclipse how quickly they warm up again.

Another kind of key experiment that we are doing on the rings is associated with the radio experiment. And a part of that is related to what we did at Jupiter with the imaging system.

(Slide.)

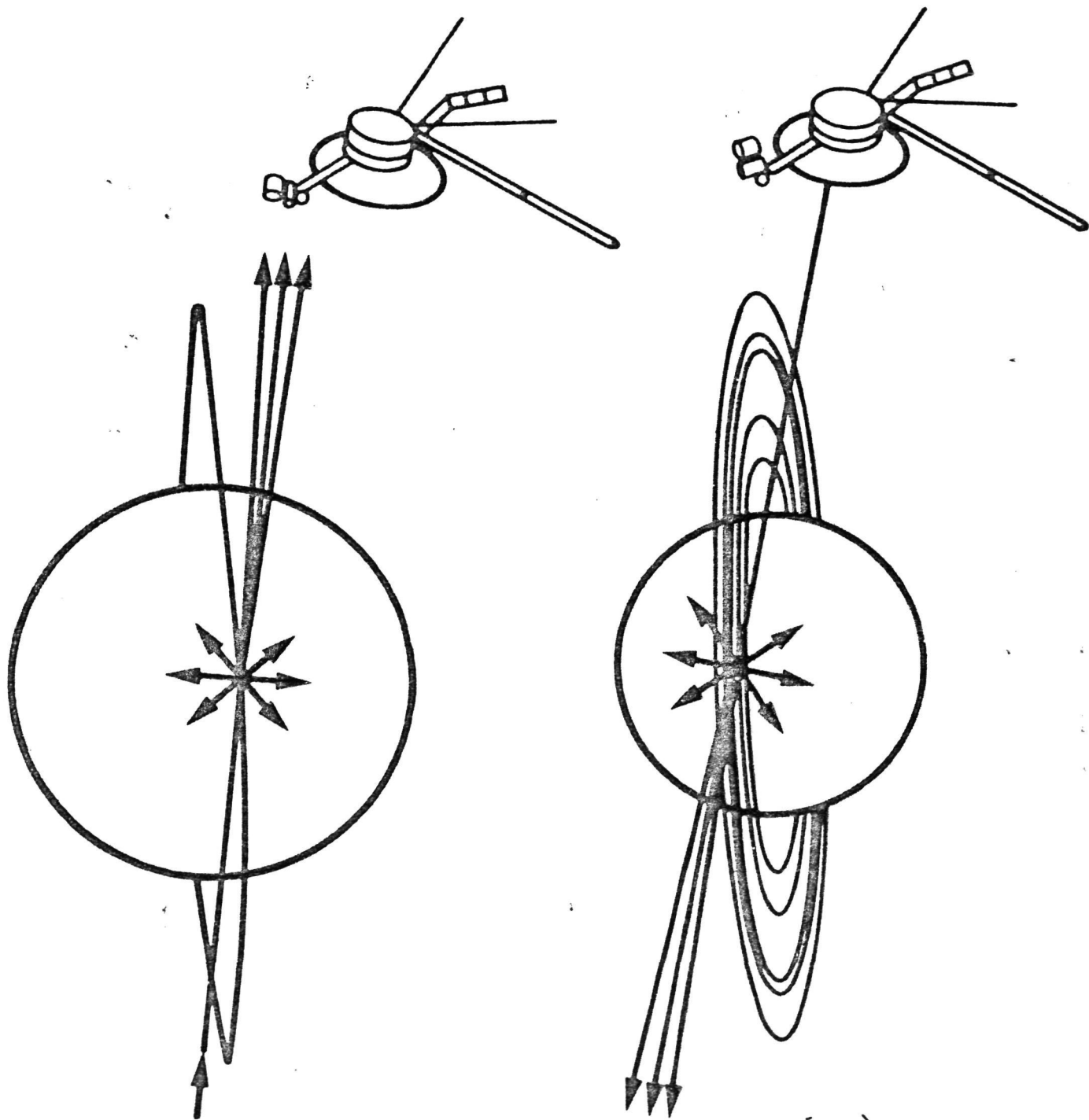
DR. STONE: The next slide shows the image of the ring taken by Voyager 2. This image was taken when we were behind the planet so that we could turn the camera and look toward the Sun. Now the Sun was being eclipsed by Jupiter so we were looking at sunlight which was, in fact, scattering off the ring at a very shallow angle on into the camera system.

Such forward scattering of sunlight is very important for the process whose particle size is five to 10 times the wave length of light.

In this case, since this is light, that means five to 10 times the wave length of visible light. These particles were a few ten thousandths of an inch in size.

Now we are doing just a very similar experiment with the radio system at Jupiter and Saturn.

(Slide.)



DR. STONE: The next slide illustrates that. Here is the Jupiter case with the sunlight coming in. The light is scattering in all directions, but preferentially scattering forward to where the Voyager camera system could see the very fine dust particles.

At Saturn we are turning the experiment around. We are using the spacecraft radio system to illuminate the rings. Again, the radio waves are scattered, as indicated here, primarily in the forward direction by the particles which are on the order of five to 10 times the wave length of the radio waves. And, of course, the radio waves are three and a half centimeters, a little bit over an inch, and 13 centimeters, something a little bit over four or five inches.

So we will be looking at particles whose sizes are that of the dirty snowballs which are thought to make up the bulk of the number of particles in Saturn's rings.

Besides this Saturn experiment, we will also look at the radio beam being directly transmitted to the rings and just see what the attenuation is of that radio beam.

(Slide.)

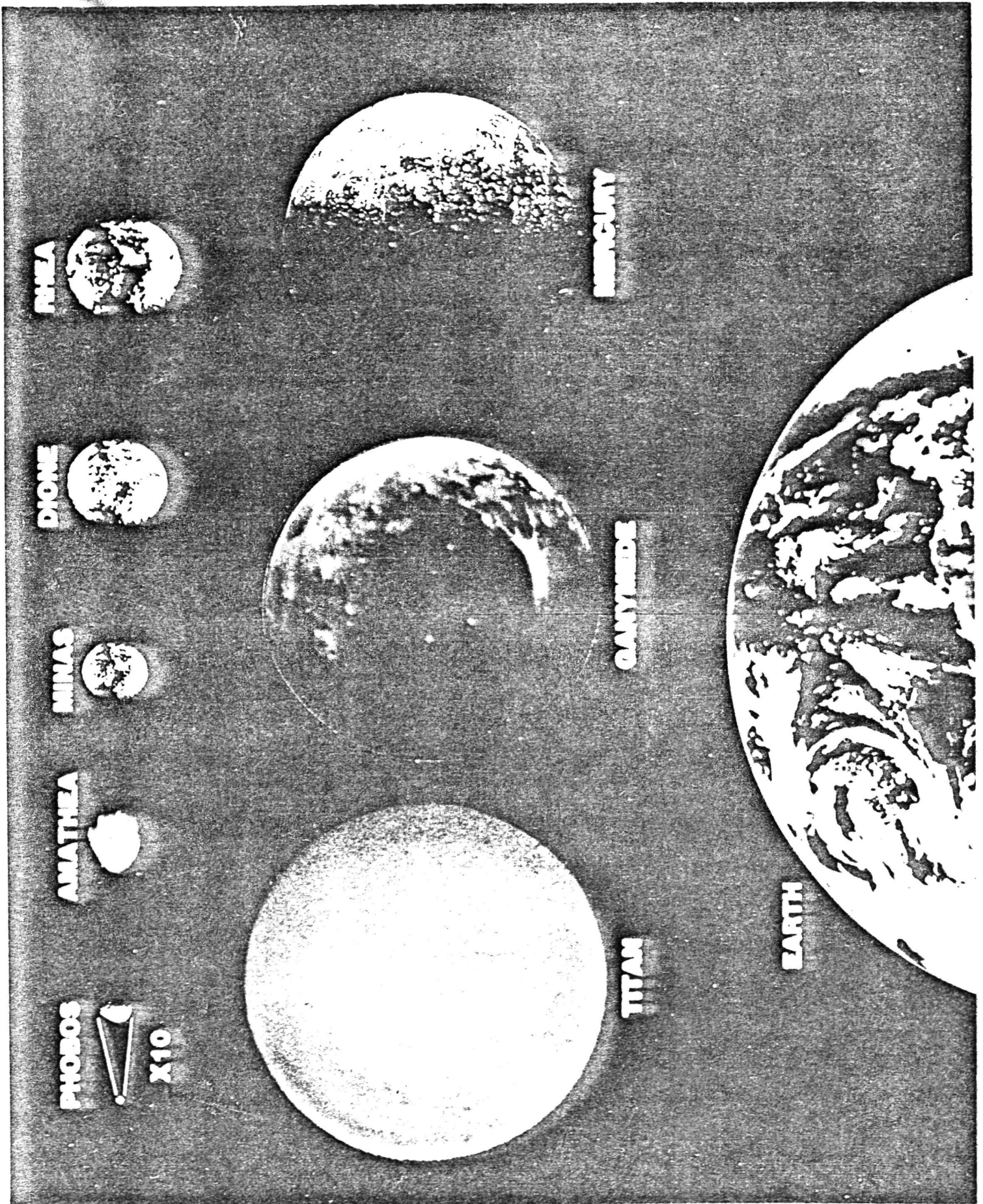
DR. STONE: The next vugraph, I believe, shows the complicated series of maneuvers that we will be making in order to carry out these radio experiments on the 12th and 13th of November.

This is as viewed from Earth. This is the spacecraft trajectory as we see it from Earth. We start at this time using a radio system to look at the ionosphere or Saturn. At this point the atmosphere of Saturn starts changing the characteristics of the radio and that tells us the temperature and the pressure of the atmosphere. We track that radio beam around the limb of the planet where we reach the deepest we can into the atmosphere.

At this point we do other experiments, and then we return to doing the radio occultation of the atmosphere on our way out. And as we come out here we are doing our exit occultation of Saturn's atmosphere.

Then we turn the antenna directly to Earth and watch the spacecraft as it goes behind the rings and in that way determine the radial transmission of the rings and that tells us something about how much total material there is, which is of appropriate size, basically between us and the spacecraft.

And then during this phase out here, this period of something over an hour and half, we will be directing the antenna of the spacecraft not at Earth, but toward the rings and then looking at the scattered radiation. You can see it is a very complex period of activity, but one which should give us a great deal of



new information about Saturn's rings. Okay, if I could go on to the next slide please.

(Slide.)

DR. STONE: I would like to now talk a little bit about the third area that we will be investigating. Next slide please.

(Slide.)

DR. STONE: Which is the satellites of Saturn. This is a composite view, and I am sorry for the -- that is Mimas up there, not Minus.

This scale shows the Earth, Mercury and Ganymede, Jupiter. The objects of which we are now becoming familiar. On this sketch of Titan to scale, roughly speaking. Here is Phobos, a small dot, which is blown up here, a factor of 10, Amalthea, and then three of the inner satellites of Saturn illustrating that these are, in fact, a new size class of icy objects, a size class that we have never imaged before.

And so given our experience of Jupiter, whenever we see such a new class of objects, I think we are bound to be surprised at what we find.

(Slide.)

DR. STONE: The next slide shows where those satellites are. The inner satellites, this is Mimas, Enceladas, Iapetus, Dione, Rhea, Titan and Hyperion, Iapetus is not shown. It would be off the scale of this particular slide.

And I will now show you some of the artists' sketches of the kinds of things we think we know about these objects and to show you the kind of resolution we will have with Voyager 1 in our close flybys of these objects.

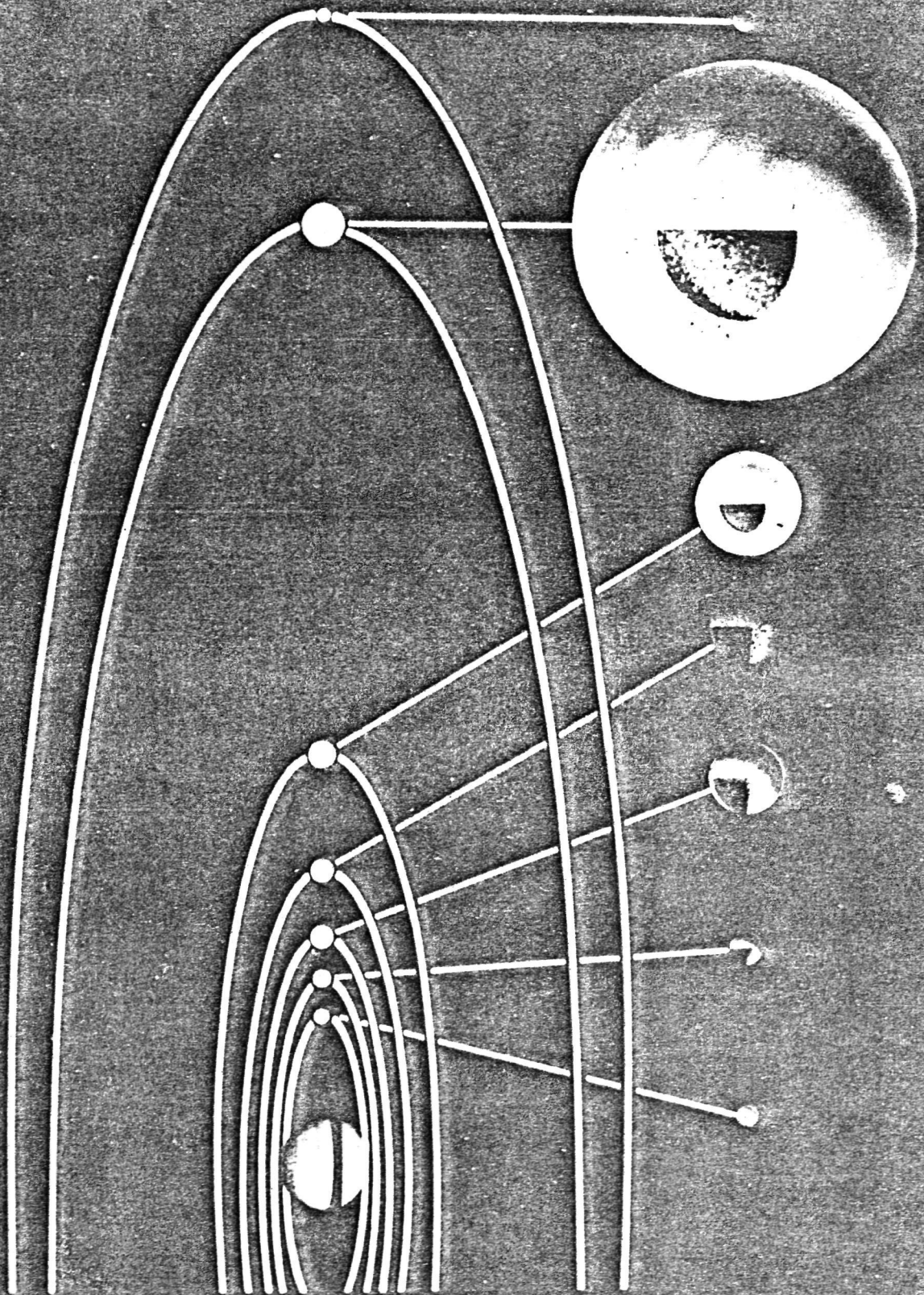
(Slide.)

DR. STONE: First let's start with Mimas, then we will do Enceladus, we will do Rhea, we will do Iapetus, which is off here, and then finally come back to Titan. So let's start with Mimas. Next slide please.

(Slide.)

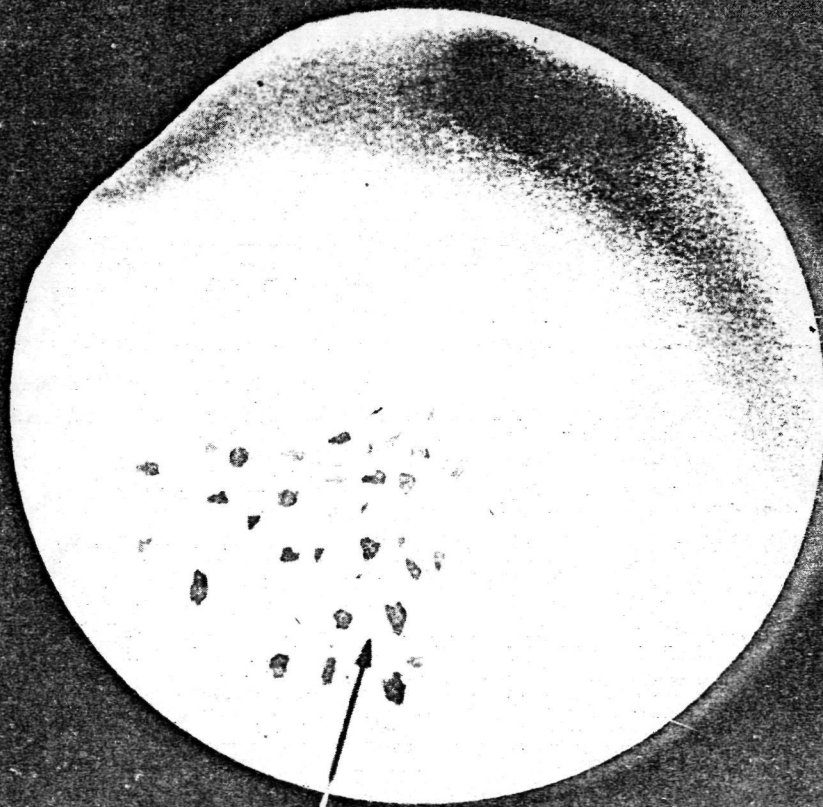
DR. STONE: This is an artist's sketch. Notice the size. It is about -- the radius of Mimas is something on the order of 175 kilometers, about 110 miles. The radius is uncertain enough, of course, once we image it we will know what it is, that if the object is larger, larger than this, it would have to be essentially pure water ice.

INNER SATURN SATELLITES



**MIMAS
S1**

**ICY ROCK
MIXTURE**



500 KM
0

If it is of a small range of the size which is deemed acceptable, it could have a significant rocky component.

Another thing this artist's sketch suggests is that these objects now are small enough that in the absence of external heating, during their formation and their subsequent radioactive decay, there would not be enough heat generated possibly to cause them to melt. And so the rock, which normally sinks to the center of the planets, might not be differentiated and it may be, in fact, dispersed.

On the other hand, maybe Mimas is close enough to Saturn that Saturn provided the necessary heat. Anyway, this suggests the kind of things which one would hope to learn, that is how large is this object, what does its surface really look like. It is a very small object and might well be somewhat battered and not a very smooth object.

(Slide.)

DR. STONE: The next slide shows the kind of resolution we will have of Mimas. It will be equivalent to the resolution that we got with Voyager 2 in Europa, about four kilometers per line pair. So this is not what the surface will look like, necessarily, but it tells you the kind of detail we should expect to see on Mimas.

(Slide.)

DR. STONE: The next slide shows Enceladas. It is a somewhat larger object, about 260 kilometers in radius but, again, you can easily have a plus or minus 25 kilometers on that and not violate anything that we know. That is about 160 miles.

Here we have shown a differentiated rocky core. The suggestion being that Enceladas, it has been suggested it has somewhat the same kind of tidal heating as Io has, not as much, but on the other hand Enceladas is a much smaller object so it doesn't take as much heat, perhaps, to cause it to have melted and for the rock to have formed a rocky core.

The other thing which is suggestive here is that there may well be a recent impact event, a geologically recent impact event, which may be, and this is a very speculative suggestion, it may be the source of the E ring material. I will come back to that point in a minute. But it could turn out Enceladas is a very interesting object.

(Slide.)

DR. STONE: The next slide shows the kind of resolution. This is, in fact, the kind of resolution that we will have on Enceladas about 16 kilometers per line pair on Voyager 1.

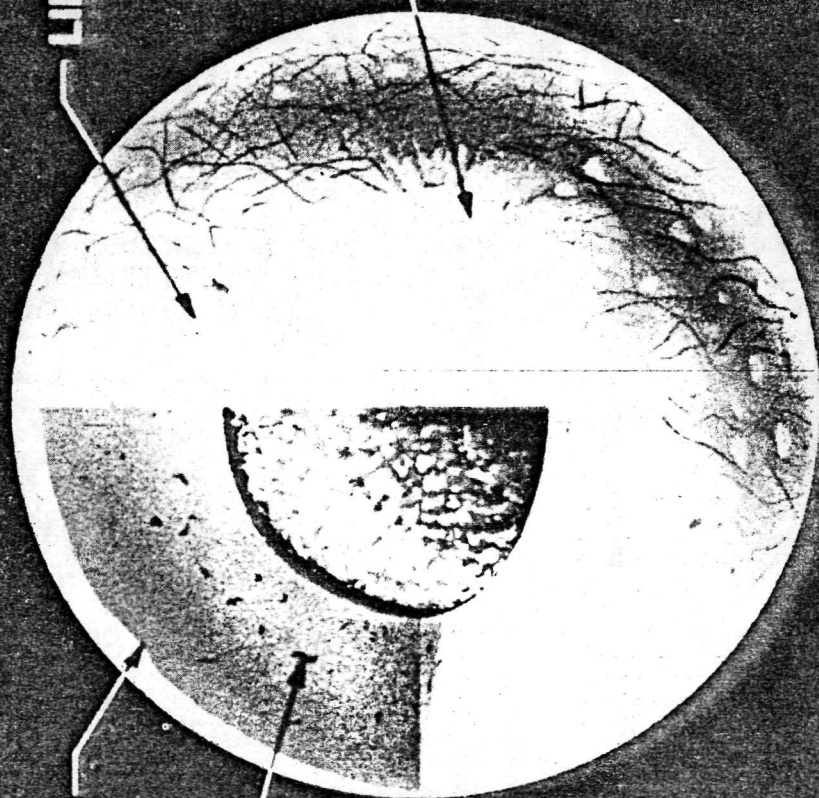
ENCELADUS S2

PUNCTURE?
E-RING SOURCE?

TIDAL
HEATING?
WATER?

LINAMENTS?

RECENT IMPACT?
E-RING SOURCE?



0 500 1000 KM

(Slide.)

DR. STONE: And the next slide shows the basis for the suggestion, the speculation, that Enceladas might be associated with the E ring. This is some data taken from the Earth using the wide field planetary camera. Some of the parts of the wide field planetary camera, Bill Baum at Lowell and Jim Westphal have reported these results recently.

This is the intensity of the light from the E ring. This is three Saturn radii. The outer edge of the A ring, the ring we can see from Earth normally, is about 2.3. So this is outside of the normal rings and you can see that, in fact, in their deconvolution of the data, at least, there is at a peak in scattered light in that ring associated with Enceladas' orbit.

Now whether it is really from Enceladas or not is, as I say, a very controversial issue. But in any case, it certainly means that there is material in the region where Enceladas is, even if it is not from Enceladas.

It also shows that our penetration of the E ring is out here where the intensity is, in fact, much lower and where we also think Dione may be clearing out the zone that we are going through.

(Slide.)

DR. STONE: All right. The next slide takes us to Rhea. Now this is getting to be a larger object, 750 kilometers, still small compared to Ganymede and Callisto and Io and so on, but large compared to the small ones I have just talked about. Large enough that even in the absence of external heating it probably has differentiated all by itself so if it, in fact, is no larger than we think it is, it probably has a rocky core as suggested here.

It may look rather similar in some ways to what we have now gotten used to seeing in the Galilean system.

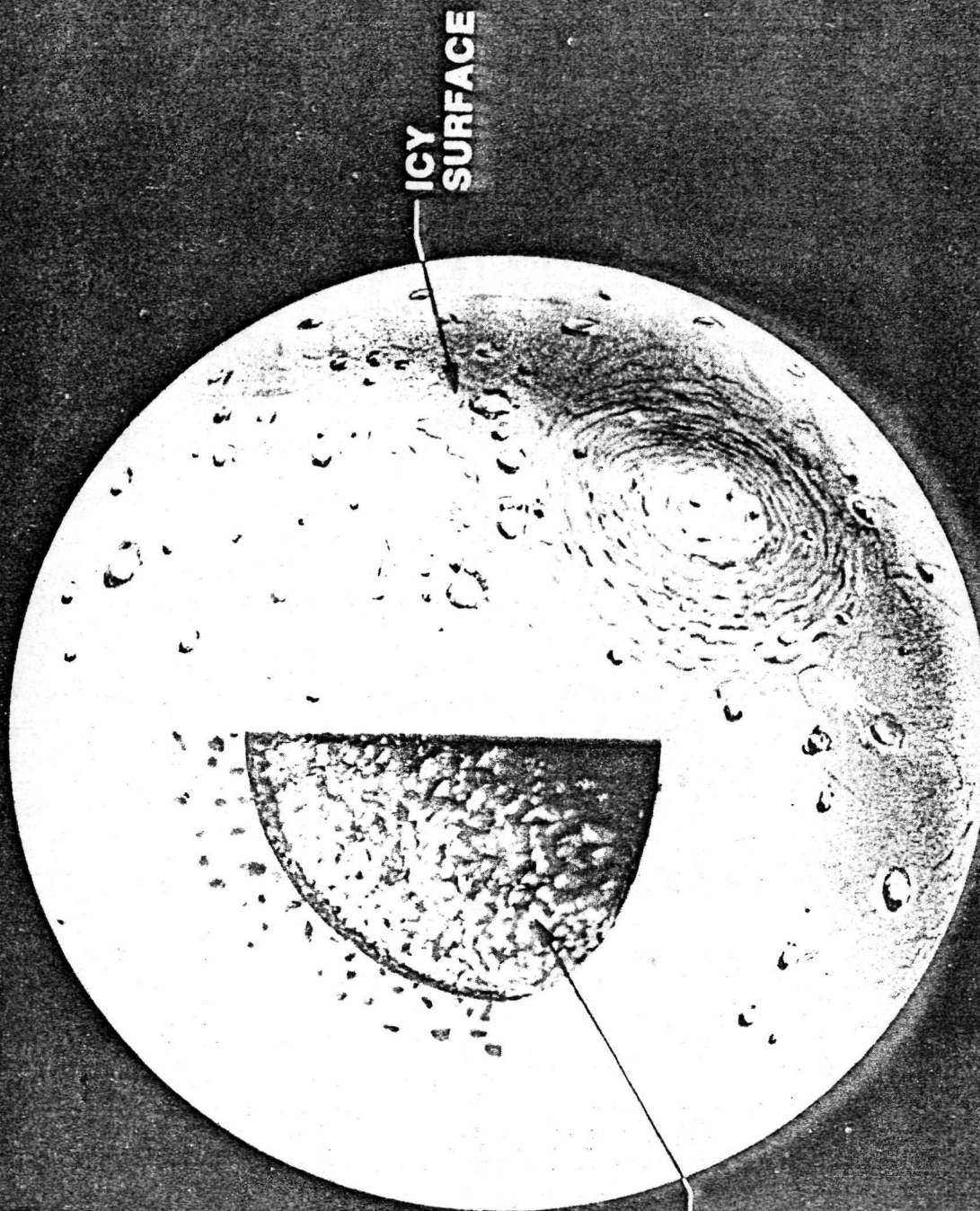
(Slide.)

DR. STONE: The next slide shows the kind of resolution we expect to get on Rhea. Remember, this is the one we are doing image motion compensation. That allows us to get resolution better than the kilometer. This is an image of Io taken with a slightly better resolution. The crater which one sees here is 40 kilometers across. So this is the kind of imaging capability we will have at Rhea.

(Slide.)

DR. STONE: The next slide steps out to Iapetus. It is one satellite we seem to know something about and we know that, in

**RHEA
S5**



0 500 1000 KM

fact, the side which comes toward the Earth leading space seems to be one fifth as bright as the trailing face, the face that we see when Iapetus is leaving Earth, if you like, in its motion about Saturn.

So there is this very large front to back brightness ratio. Then they show you the kind of resolution that we will expect to be getting at Iapetus. Next slide please.

(Slide.)

DR. STONE: It is about 47 kilometers per line pair, similar to this image of Ganymede. Now let me remind you Ganymede is a much larger object, but the size of the features in the scale that we will be seeing is indicated by this view of Ganymede.

Let's then make a step back in to the giant of the Saturnian system, Titan, Next slide please.

(Slide.)

DR. STONE: Titan is, of course, extremely interesting because it has an atmosphere, an atmosphere of methane, of natural gas, if you can imagine such a thing.

Unfortunately it seemed to be a rather cloudy atmosphere. We are hoping that it is not totally cloudy, but I don't know that many people would give you very good odds as to how many holes we are likely to see in the cloud deck.

We believe it may well be very similar to a Ganymede or Callisto underneath that cloud deck. And that there is a surface indicated by this brown line, which may have some rather interesting characteristics if, in fact, we are fortunate enough to be able to see the surface. The next vugraph please.

(Slide.)

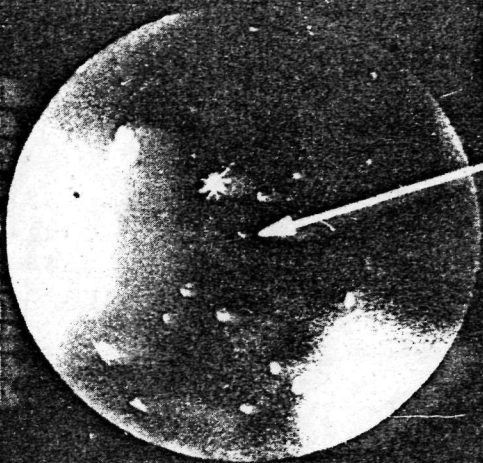
DR. STONE: Indicates some of what we know about Titan and some of the areas that we would hope to be working on. The surface temperature, which was determined recently from using the very large array in New Mexico, is 87 plus or minus nine degrees Kelvin, very cold.

The radius determined from the same measurements is 2,400 plus or minus 250 kilometers. I would like to point out that if you take a 2,200-kilometer radius, which is certainly consistent with the data, that would suggest a density for Titan similar to the density for Europa, in which case it would break up.

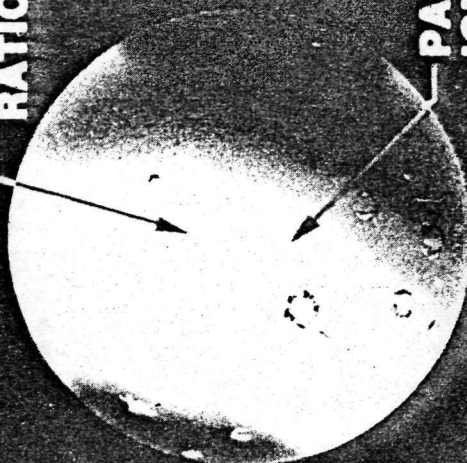
On the other hand, if we take this radius it would suggest a density rather similar to that of Ganymede, hence an object which is half waterized. If you asked me, I would guess this is more likely the case, but that is really just based on the fact that

IAPETUS S8

LEADING FACE

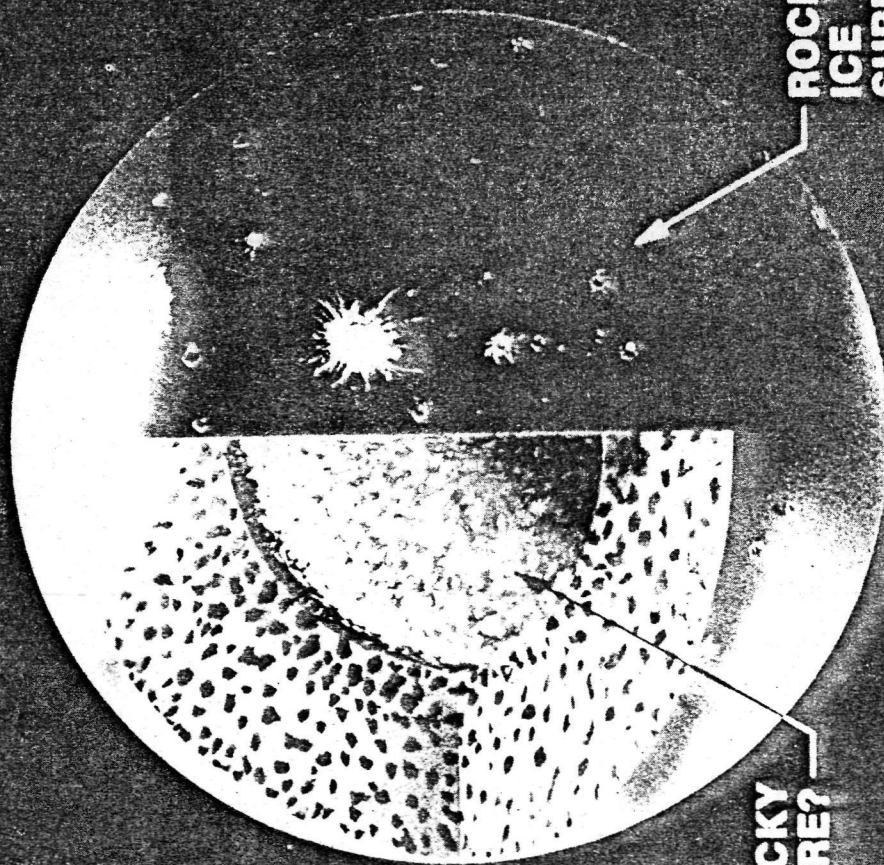


5 TO 1
BRIGHTNESS
RATIO



PARTIAL
ICE
COVER

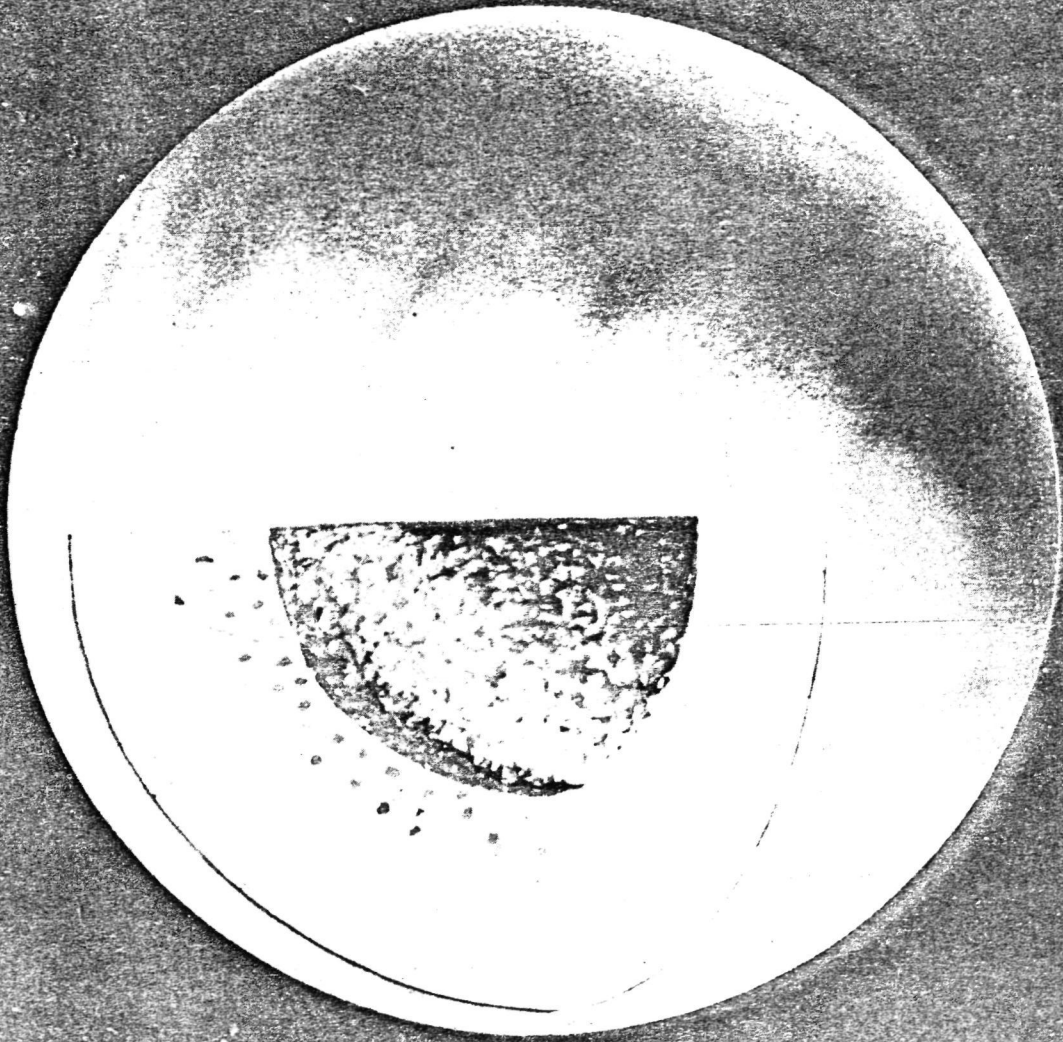
TRAILING
FACE



ROCKY
ICE
SURFACE

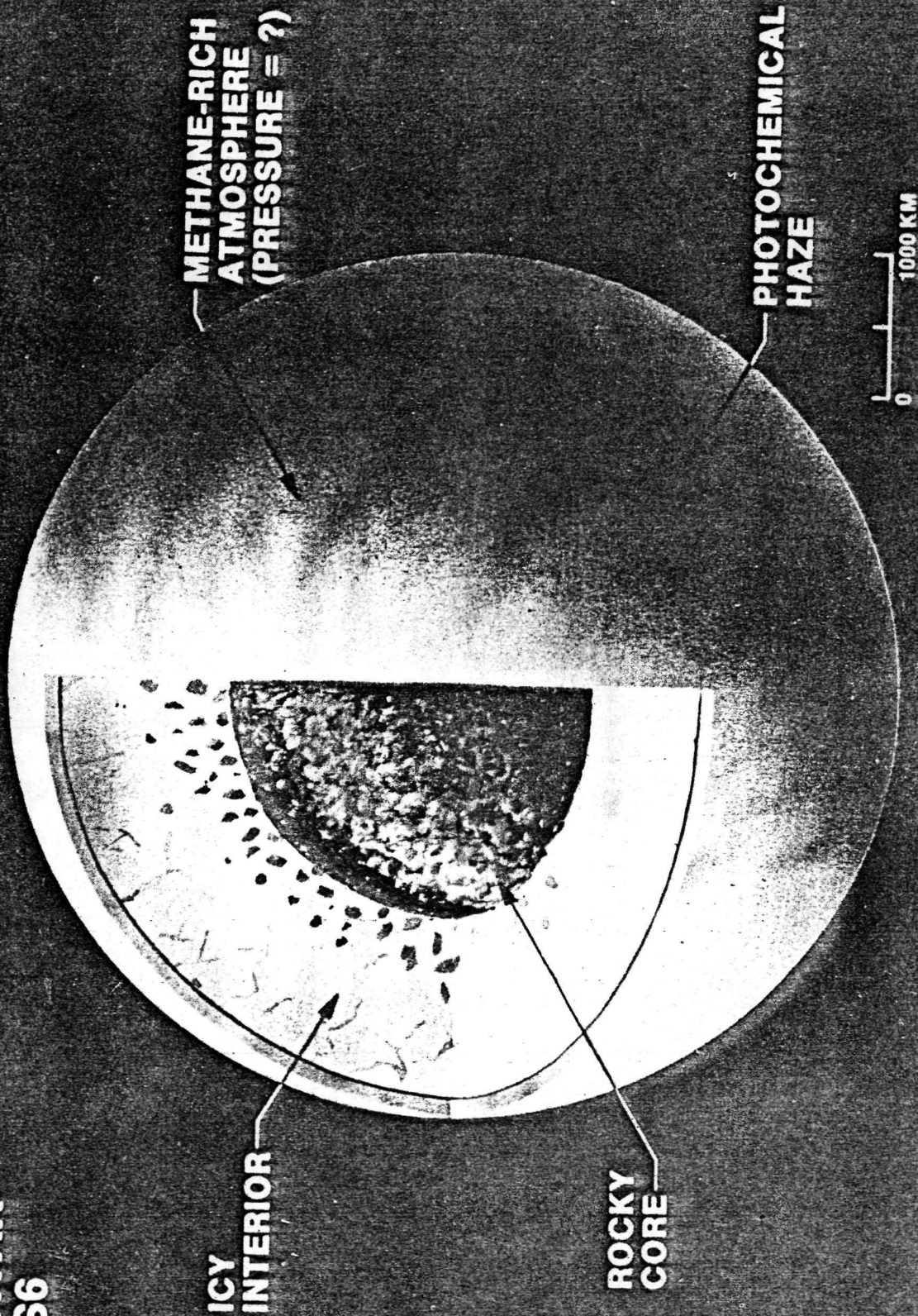
ROCKY
CORE?

0 500 1000 KM



TITAN
S6

TITAN S6



one expects there to be more volatiles out in Saturn's region which would contribute to the more icy-type object.

We will directly measure the radius of Titan with the radio occultation experiment and should for once and for all determine what that radius is and what kind of an object is buried underneath those clouds.

The characteristic of the surface, well it has been pointed out that at 91 degrees Kelvin, which is within this temperature range, one can actually have a liquid methane, liquid natural gas on the surface. If there is a substantial component of nitrogen, or carbon monoxide or argon in the atmosphere, one might expect some liquid of those gases on the surface. In any case, if it is a solid one would expect it to be a cold trap where some of the photochemical materials that are made in this methane atmosphere are trapped out on the surface giving maybe kind of a gooey mess.

The atmosphere itself, the Pioneer 11 and some ground based data tells us the atmosphere is about 75 Kelvin, which is just the temperature one expects for something in equilibrium with the amount of sunlight it is receiving. No indication of any internal heat source.

The radius determined from Pioneer 11, as you notice, is larger than the radio radius and that tells us the atmosphere. If you take this limit for the solid radius, you see the atmosphere is some 200, 250 kilometers deep, a very deep atmosphere.

If it is pure methane, it would only be two percent of the Earth's atmosphere surface pressure. But there could be as much as two atmospheres of nitrogen there and we could not tell that from Earth.

There could also be neon there, carbon monoxide. We would be unable to tell that from Earth. But we will be able to tell what the total surface pressure is, whether it is 20 millibars, or whether it is two bars. Whether it is two percent of the Earth's atmosphere twice, from the radio occultation experiment. And, of course, there are considerable aerosols as determined from the Pioneer data in the atmosphere which makes it very, very hazy looking.

(Slide)

DR. STONE: The next slide shows some of the key -- I am sorry, next vugraph. Bill, will you pull back to the vugraph. I am sorry.

(Slide)

DR. STONE: This is our flyby of Titan. Nominal closest approach is somewhere around 7,000 kilometers, it may be more like 6,500 kilometers from the center of Titan and so you can see from

the surface will be something on the order of 2,500 kilometers from the surface.

It is during this time period, right here when we disappear behind the planet as viewed from the Earth, that we will probe how deep the atmosphere is and what its temperature is, right down to the surface. So we should also be able to confirm the temperature of the surface using the radio occultation measurements made at these two times when the radio beam is being beamed back toward the Earth.

We will also, during this time period right here, look at the region that we expect to see a weight in the plasma associated with the rotating magnetic field which is rotating around Saturn this way and which should create a weight, a trailing weight, about Titan and which may be an important part of understanding the Titan -- the Saturnian magnetosphere.

Well, that does in fact lead into our fourth area. The next slide --

(Slide.)

DR. STONE: -- shows comparison of the Jupiter and Saturn magnetosphere now based on Pioneer 11 results from September 1979. This is -- both of these sketches of the magnetic fields of Jupiter and Saturn are done for the most compressed state. Recall that when the solar wind is very, very strong it compresses the magnetospheres down nearest to the planet.

In the case of Jupiter that can be as short a distance as 3 million kilometers or about 2 million miles.

In the case of Saturn it is only one third as large in its most compressed state, maybe only a million kilometers or 600,000 miles. On the other hand, both of them could be two to three times larger than that.

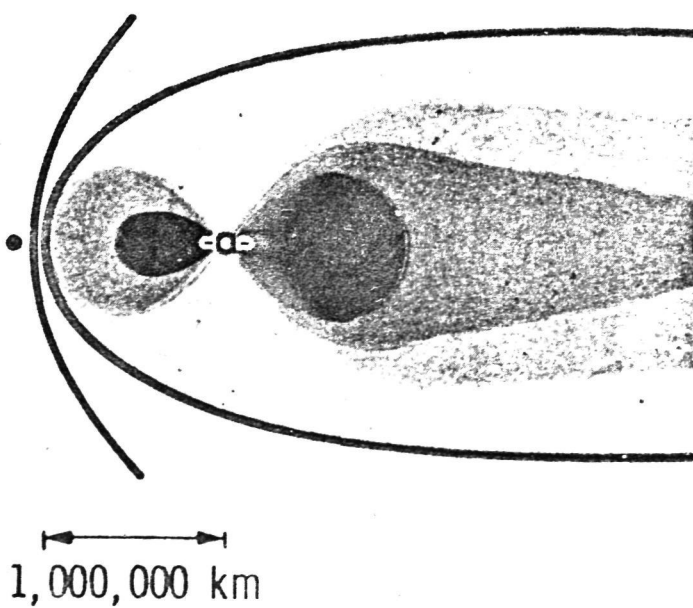
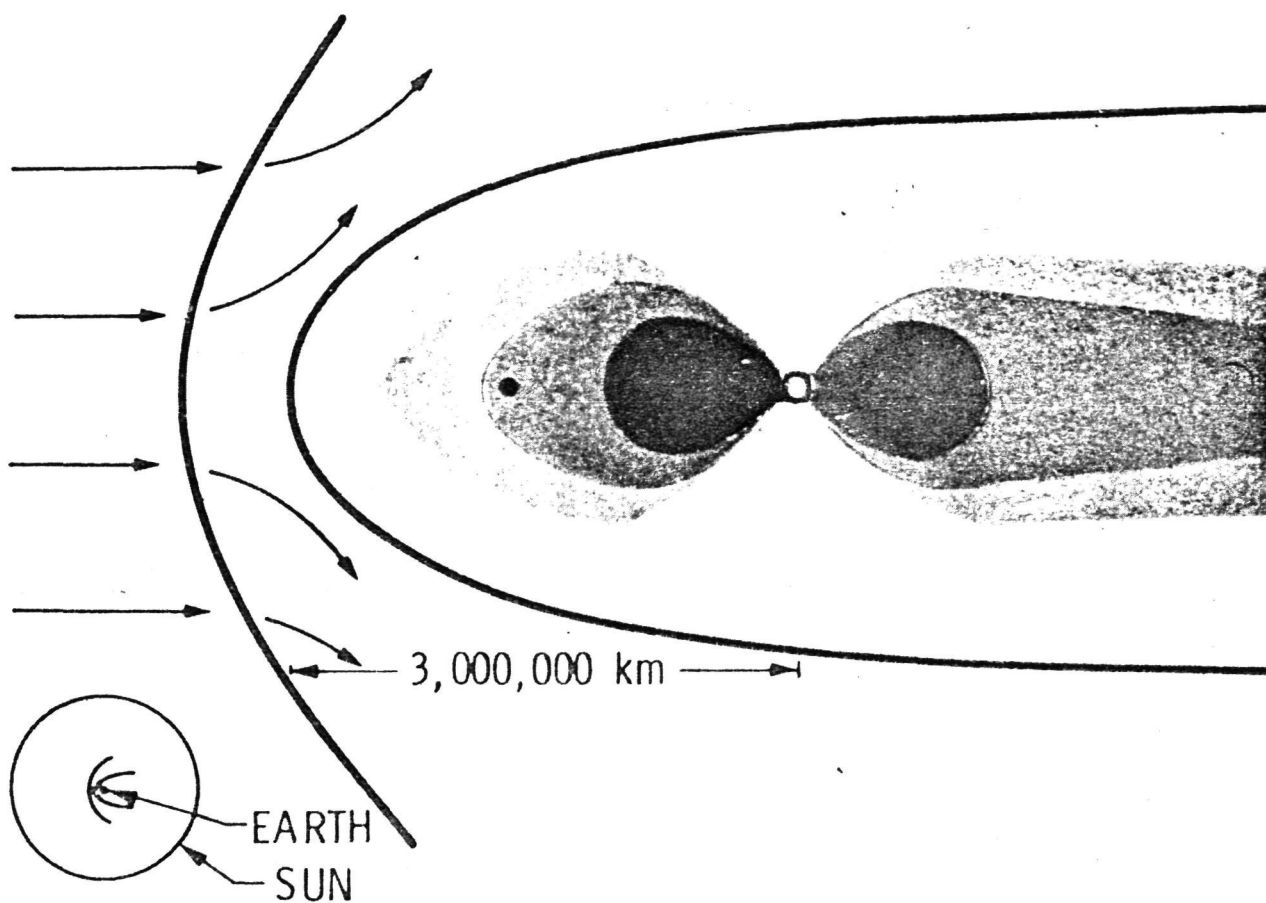
The scale, here is our Sun and there is the Earth's magnetosphere. So, again, even though it is relatively small compared to Jupiter, it is still a very large structure.

The interesting thing is that all of the major satellites of Jupiter, this is Callisto, Ganymede, Europa and Io are inside and always inside of Jupiter's magnetosphere, but Titan, in fact, finds itself either inside or outside and I will come back to that point in a moment. Could I have the next slide?

(Slide.)

DR. STONE: Another thing which Pioneer learned, which we will be investigating more closely, is illustrated in this split view of Jupiter on this side and Saturn on this side. There is a rocky core. And Jupiter, the metallic hydrogen, the electrically

JUPITER



SATURN

conducting hydrogen, fills up this much of Jupiter and that is the region where presumably the magnetic field is being generated.

In the case of Saturn, this is somewhat smaller and lower mass, that region is much deeper inside the planet. The net result is that since the fields, the magnetic fields generated tend to be most distorted near the region of their generation, in the case of Jupiter that distortion extended out to where we could measure it. But in the case of Saturn, presumably that distortion is all hidden inside the planet itself and all we see outside is, at least from the Pioneer results, are rather regular, very smooth fields.

Now what we can do on Voyager to add to this picture is relate it to the fact that the Pioneer trajectory scanned in like this and backed out like that. Its sensing made an equatorial pass through the magnetic field.

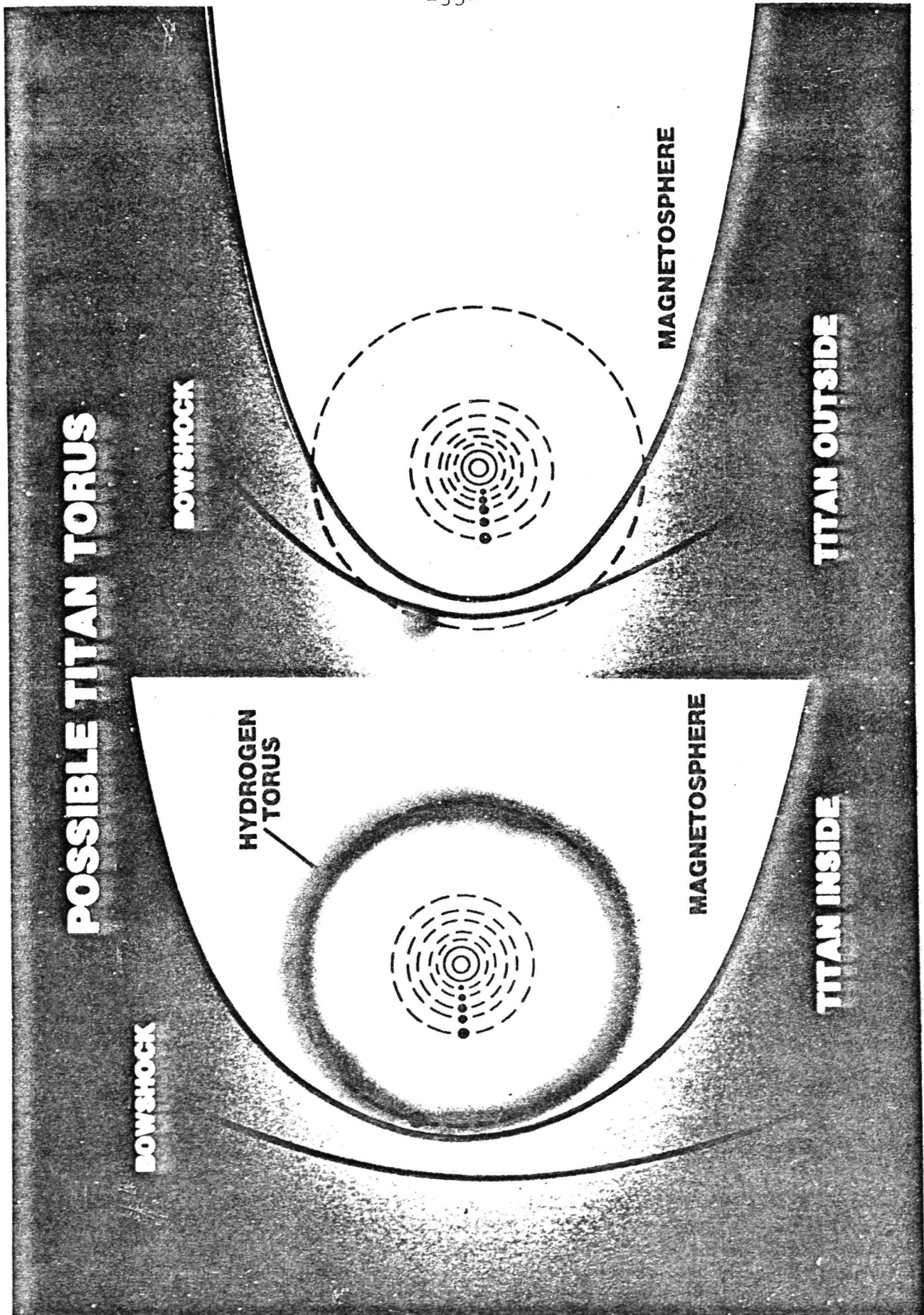
Voyager, on the other hand, will do something like this. It will come in, it will come 40 degrees south before it turns and hits north and out. So we will be investigating the magnetic field at these higher latitudes where, in fact, we may find evidence for some distortions similar to those which are quite obvious in the case of the Jovian magnetic field.

(Slide.)

DR. STONE: The next slide shows the story for Titan, which I have already alluded to and that is if the magnetic field, the solar wind is not blowing hard, Titan will be entirely inside during its full orbit, inside the magnetic field, and we expect that it most likely will, just as Io did at Jupiter, provide the source of material of a complete torus of material surrounding Saturn. A torus at least of hydrogen that one might expect with a complex atmosphere which includes methane, that there might be some other interesting species, chemical species in this torus and we will be scanning this torus with the ultraviolet spectrometer and, of course, measuring directly with our plasma instruments the material in these regions.

If the solar wind is very, very strong, as it was at the time of the Pioneer entrance into Saturn's magnetosphere, we will find Titan outside. And, of course, we will encounter Titan in front of Saturn, in which case one would expect, perhaps, that the complete course will not exist, but perhaps there will be a cloud similar to the one which was observed by Pioneer 11 just in the direct vicinity of Titan itself.

Well, I believe that gives you -- there is one other thing that we expect which is hinted to by Pioneer 11 and that is that the ring material also will be a source of ionized species which will couple into the magnetosphere. We will get, we expect, a complete torus of at least hydrogen from the water which is in



Saturn's rings. We may well find, again, other species which are being small, being broken off of the ring material themselves by the intense radiation bombardment which occurs at their edge.

We will be looking at these things, of course, during the time of closest approach on Nov. 12th.

Well, as I look forward to these next few weeks, I kind of think back to a similar press conference we had a year and a half ago here prior to our Voyager 1 Jupiter encounter and I realize how much we learned in those succeeding two weeks. It was really a fantastic period in terms of discovery.

Then I add to that the fact that today we know even less about Saturn than we knew about Jupiter at that time and I can only conclude that the next two weeks are indeed going to be exciting.

Brad Smith now, in fact, will give you some of the first exciting results.

STATEMENT OF DR. BRADFORD SMITH, VOYAGER IMAGING TEAM
UNIVERSITY OF ARIZONA

DR. SMITH: Well, as Ed Stone has said, Saturn is an object very similar to Jupiter both in size and bulk composition.

It also has a convective atmosphere and in that sense it is different from the Earth, but similar to Jupiter's. The Earth is baroclinic atmosphere where heat comes in in the equatorial regions and works its way up to the polar regions and that transfer of heat from the equator to the pole is what gives us our winds and our weather.

On Jupiter that process may be taking place but it is dominated by the internal heat, which is flowing out. It doesn't really know whether it is coming out of the equator or the poles.

Now, Saturn has a similar type of convective system and the question is, is the weather, is the meteorology, are the atmospheric currents on Saturn, are they like Jupiter? The answer is, we don't know yet and we have very little information, or have had very little information to go on.

(Slide.)

DR. SMITH: The first slide shows the way Saturn looks from the Earth, one of the better pictures that have been taken from the Earth's surface and in all of the photographic history that we have of Saturn from the Earth's surface, only nine clouds have been spotted in Saturn's atmosphere that have allowed us to make wind velocity measurements.

The Pioneer didn't help very much. Next slide.

(Slide.)

DR. SMITH: One can see the banded structure, but none of these, what you call non-axisymmetric features, spots, clouds, what have you, little indentations, in the belts show in the final picture. Next slide.

(Slide.)

DR. SMITH: This shows another picture.

(Slide.)

DR. SMITH: And the next slide shows the highest resolution Pioneer picture. And when we were looking at these pictures, particularly the enhanced or the processed versions about a year ago we were scared to death because there just wasn't anything there and we were very much worried about whether or not we would be able to actually carry out that part of our experiment.

Well, fortunately Voyager is showing us features in the Saturn atmosphere.

(Slide.)

DR. SMITH: The next slide will show them to you. It is just a fairly high resolution view of Saturn taken about 10 days ago and if you look at the handouts out there you may begin to see some little structure, little features that can be tracked.

You may also notice that right in the middle of the Cassini Division is a little bright ring, and that was one of the earlier discoveries of this Voyager encounter.

If we go to somewhat more highly processed versions -- next slide.

(Slide.)

DR. SMITH: Excuse me, this just goes back and shows essentially what we have done from the Earth and from what we see here is a Jupiter velocity profile as a function of latitude. That could be focused a little bit better. This is the equator, 30 degrees north, 60 degrees north, and this is the velocity in meters per second, very difficult to read, but this is minus 100, plus 100, that is plus 100 in the direction the planet is rotating, 200, 300, 400, 500 and so on. And this is what the velocity profile of Jupiter looked like. This is that so-called equatorial jet, equatorial acceleration.

Now the red dots represent the points that have been measured from the Earth, essentially zero up at very high latitudes, even small velocities on the order of 15 meters per second or so in the mid latitudes, and then this enormous equatorial accelera-

tion that is going out here somewhere around 400 meters per second.

Now, defined structure we don't have. And it is this structure that in the velocity profile the Voyager will provide.

Already we are beginning to see some of this. Next slide.

(Slide.)

DR. SMITH: It shows another image of Saturn taken on the -- about 10 days ago and here, if you look very carefully, you can begin to see dark features and some little bright features, but let's look at the individual black and white images because they show more. Next slide please.

(Slide.)

DR. SMITH: Here we can now -- this is violet (?) image and we can begin to see some little bright spots. At this latitude you see an embayed region of a bright zone and that can be tracked and well, there are others, but let's go to the green image of that same set and we can now begin to see a little bit more in these bright spots, dark spots. This is a defect. And although it doesn't show clearly in this image, there is a great deal of structure in these regions. And some images that I looked at a few days ago have not yet been processed for release show literally dozens, maybe even hundreds of small features that we will now be able to track. Next slide.

(Slide.)

DR. SMITH: It shows that same color image, but now using false color where we substitute the ultraviolet for short wave lengths and this gives us some information on the scattering properties of Saturn as well as making a nice psychedelic picture.

Here we can see the UV bright limb due to scattering of particles high in Saturn's atmosphere. It also shows that there are quite different reflectivities or albedos of the different belts and zones shown by the color that this thing in this false color image --

Well, let's go to the ring now. This is a Pioneer view. As Ed so mentioned there are three classical rings, the so-called A ring, B ring and C ring, that have been known for centuries now.

In the mid to late 60's two new rings were thought to have been discovered, the so-called E ring, which ground-based observations in 1980 now show to be very real and a suspected D ring, which is inside the C ring, which has not yet been confirmed.

However, the Pioneer image began to show that there was some structure in these rings. Well, this is a new ring that was seen

by Pioneer, the so-called F ring discovered by the Pioneer. And one can begin to see the little thick belts in this image, a little structure showing up in these rings. Again, this is a view from the unlit side and so the very dense rings appear very dark.

(Slide.)

DR. SMITH: The next image shows a Voyager view and I have three different versions of this so you can see some of this structure beginning to show up. All of these concentric features that are now beginning to show up in what used to be considered a uniformly bright B ring, here structure beginning to show up. This is the so-called Encke Division which is not seen from the Earth and another view now will emphasize certain parts. Let's look at the next slide.

(Slide.)

DR. SMITH: Yes. This is just a higher contrast version of what we just looked at. You can see more and more structure. There are literally dozens of these concentric features that are beginning to show up in the rings now. There is no nice uniform part of any of the rings. Next view.

(Slide.)

DR. SMITH: Shows the inner part, the so-called C ring and even it is beginning to break up. So we can see a very dark gap here, another one out here and so on.

Well, what causes these divisions. The next slide --

(Slide.)

DR. SMITH: -- shows a profile, the profile that we have from a recent Voyager. In it is the F ring, rather, that was discovered by Pioneer, the so-called Encke Division, the Cassini Division with the little ring in the middle of it, and all of this structure that is beginning to show up in the C and the B and A rings.

Now at one time it was thought that these divisions were due to resonances from satellites. If you had some particular distance out from the center of Saturn where the orbital period of the little ring particles was some multiple of a satellite, maybe a third or three times the satellite period, then every three orbits of that ring particle, it would be alongside of some particular satellite. And this produces a small force.

Now if these are commensurate, that is if they are -- if the particle orbits of the rings are small number, integer number ratios to the orbit of the satellite then the satellite hits it in phase each time sort of like pushing somebody on a swing. If

you push them at the backstroke each time, or every other time, or every third time, they keep getting higher and higher. But if you do it randomly they don't go anywhere.

So it was thought that this was the mechanism that was producing these features in the rings. That could still be the mechanism, but now we are beginning to have our doubts. There are too many features showing up, too many to be explained by satellite resonances, unless there are a lot of satellites out there that we haven't seen. And it would take quite a few to explain. So we will have to look for some other mechanism to cause the structure in the rings. Next slide.

(Slide.)

DR. SMITH: It shows a false color picture of the rings. Here one can see the light ring in the Cassini Division. If you look at it very carefully it now appears to be splitting into two, so that there is a little dark lane that runs down through the middle of it. But you will notice that in this false color image that the C ring seems to have a different color and that may indicate that it is made of different material.

(Slide.)

DR. SMITH: Now the next slide shows something which is really puzzling to us and is one of the more significant discoveries of Voyager 1 so far. This is a result painted into that, but this is very real. It is a dark feature extending radially outward in the B ring. It is dark, suggesting that there are a fewer number of particles right here than there are elsewhere in the ring.

(Slide.)

DR. SMITH Now the next slide shows some other samples of this sort of thing. Here we can see maybe five of these things, here a couple of them, another one here, another here. What is causing these features? That we don't know right yet.

There is a problem with them. We shouldn't be seeing coherent features like that in the rings because every point in the ring is rotating around at a -- revolving around Saturn at a different rate and, in fact, although features in the rings right here, particles in the rings right here have a rotation of something of the order of say 10 hours, the outermost part of these azimuthal symmetries are rotation around at something like an hour or an hour and a half less than the rotation period of the inner part. Now that should cause them to spread apart much in the way if you have a football formation, or a band formation marching across a football field, if every member of that band is marching at a different rate, the pattern quickly breaks up and that is what we would expect here.

Yet, we have seen these things hold together reasonably well for as much as three hours. The question is, what is holding them together? What is causing them to form in the first place? The answer is, we don't know. Suggestions have been made that they may be due to perturbations of satellites that I think should be investigated. Another suggestion is that we need to treat the rings as a hydrodynamic problem and maybe even as a magnetohydrodynamic problem.

A hydrodynamic problem would suggest that the individual particles are communicating with one another and that this may be some sort of a wave phenomenon. Magnetohydrodynamics would suggest that they are somehow or other interacting with the magnetic field of Saturn.

In any case, as soon as these were discovered we made a change in one of the sequences, a so-called movie that was designed to look at Saturn. We took half that movie this past weekend, pushed it over to look at the rings and we now have some fine information which has not yet been analyzed showing in detail pictures every four minutes, I think, how these things form and dissipate. So soon we should at least have a feeling for what mechanism is going on.

Finally, a word or two about satellites. As Ed Stone mentioned, we are encountering an entirely new class of satellite, not just in the range of size, but also in the density of perhaps bulk composition. We are seeing objects which have a density close to one, implying that they are, perhaps all water. And this should be very interesting to see what sort of surface features that we see.

We have been asked, that is as a team, to speculate on what sort of things we were going to see. We were burned pretty badly with the Galilean satellites, so we are not about to do that, but we are happy that Ed Stone's artist has taken the heat off of us.

Now, announcing discoveries, let me just say that in this ring movie that we did over the weekend two new satellites of Saturn were found.

Now Saturn now has approximately five new satellites from what the textbooks said. They are the so-called 10th and 11th satellites that were discovered back in 1966. There was a great deal of controversy over those, whether one or more even existed. Ground-based operations, particularly those carried out at the University of Arizona during the spring of this year allowed us to confirm those objects and to track them well enough to locate them early in the Voyager frames and we think we have located them early enough so that we are now able to get into the sequence photographs, high resolution photographs of those two objects at our closest approach.

There was, from the ground, another satellite discovery in

Dione's orbit, the so-called triangular libration point. It is running about 60 to 70 degrees ahead of Dione and very small on the order of 80 kilometers.

However, Voyager has now discovered the 13th and 14th Saturn satellites. They are in the range of 250 to 300 kilometers. One is about 2,000 kilometers outside of the F ring that puts it at a radius of about 142,000 kilometers and the other, the second, which was discovered I think this Sunday, is about 500 kilometers inside the F ring, that is between the F ring and outer edge of the A ring and has the radius of something on the order of 139,500 kilometers. There are no names given to any of these satellites yet.

Well, as Ed said, practically everything that we are seeing now on Saturn is brand new. That is what makes it so different from where we were at this time in the Voyager encounter with Jupiter. A lot of what we saw was sort of confirming our ground base, the suspicions or theories. Almost everything is new in Saturn. So from a point of planet theory exploration we are involved in a very, very exciting adventure.

MR. PANAGAKOS: Thank you, Brad. If we could have the participants --

DR. STONE: Nick, do you want to see the film or not?

MR. PANAGAKOS: Oh yes, yes. We have a very, very, short film that we call a rotation film that Ed Stone will describe and narrate.

(Movie)

DR. STONE: Between Sept. 12th and 14th we spent time taking images in order to construct the so-called rotation movie of Saturn and the ring system. The distance was about 80 million kilometers at the time and if we could have the film. It is a very short film.

And, of course, because Saturn itself has -- you can see the satellites very clearly moving in orbit about Saturn. It is difficult to see in Saturn's atmosphere, in September, to see any features at all that would allow us to detect the rotation of the planet, although as Brad showed there are now such features.

It is this region up here in the ring, where if you spend your time looking you may be able to see some indication of these dark features and there will be one more pass through this where it has been enhanced in order to concentrate on this region in the rings.

Again, as Brad said, we just this last weekend repeated this movie, making the movie, at a much higher resolution of this region and so the short strip I am about to show you will be soon

outdated.

So this is now the same film, but specifically enhanced to look at the rings. So very quickly just look up here. You will see one dark structure after the other rolling over the top of the image. And those are the dark structures which Brad mentioned in the still photographs.

VOICE: Which ring are those in?

DR. STONE: Those are in the B ring. That was time-lapse photography, yes.

VOICE: At what interval between frames?

DR. STONE: It was about 4.8 minutes.

MR. PANAGAKOS: If you will halt for a brief hiatus we will have questions. If the participants will gather on the stage at the table and they will be joined by Gus Guastaferro who I remind you is the Director of Planetary Programs and he will also entertain questions.

Could I ask to wait until the mike gets to you before you ask your question, since this is being recorded and it would be helpful for recording purposes if you would identify yourself. I guess we are ready. Questions? Bill?

MR. HINES: Bill Hines of Chicago Sun Times. This is for Brad Smith. I want to review the bidding on these five satellites. One of them, I guess, is Janus resurrected, is that right?

DR. SMITH: There is a political problem with this. Janus was a perhaps prematurely announced discovery by a French astronomer.

He had this satellite in an orbit that had a period of 18 hours and was some 160,000 kilometers from Saturn. We now know there is nothing in that orbit and the most likely explanation is that he was confused in his measurements or his times, or something, and got the wrong orbit for it.

So at the moment we just really don't know what to do with that name Janus.

MR. HINES: Well, to follow up, where are the two new satellites of Saturn other than the ones that were just inside and just outside the F ring?

DR. SMITH: Well, curiously they are in the same orbit and at the moment, anyway, the radial distance between those two satellites is about 50 kilometers, which is much less than their diameters, and so one right now is closing on the other with no

room to get by.

Now, we know that that can't be because they are still around and so there are some mechanisms that one might imagine where they interact with one another and exchange orbits.

MR. HINES: They are rotating around each other in some complicated fashion?

DR. SMITH: They are both going around Saturn in almost the same orbit. Out of 151,400 kilometers for the radius of that orbit, the two orbits are only 48 kilometers apart and yet they have diameters of the order of 200 and 300 kilometers. So you see there will be an interesting interaction that will take place a few years from now and might be witnessed by space telescope.

MR. HINES: One final question. Will you be able to get images of that strange situation during the pass of the Voyager?

DR. SMITH: No, not by Voyager 1 or Voyager 2. As I mentioned, these two objects are closing on one another, but that encounter will not take place, I think, for another two years or so.

MR. HINES: But you will image the --

DR. SMITH: Oh yes, we will image the individual satellites.

MR. PANAGAKOS: Jonathan?

MR. EBERHART: Brad, did you say that the 13th and 14th satellites were discovered from the images that were programmed for your ring movie?

DR. SMITH: Yes. In fact, we had suspected them perhaps a week or so earlier, but in this ring movie you can just see them going out and sailing around. So they were confirmed over the weekend.

MR. PANAGAKOS: Another question?

VOICE: For Dr. Stone. On one of Ray Heacock's slides, after the encounter sequence, this is going on out of the solar system, there was a notation that said "edge of the solar wind 1990." Are you modeling the heliopause to be that close to the Sun?

DR. STONE: That is just an artist's indication. We don't know where the heliopause is. So it could conceivably happen in 1990. We will be something over 30 astronomical units from the Sun at that time with Voyager 1 and 2. It is conceivable. It could though, on the other hand, be more like 50 astronomical units which would take us another seven years.

VOICE: More related to this mission, you said that Voyager 1 will be leaving the vicinity of Saturn at 35 degrees to the ecliptic plane. That is real steep. Will that give you data from higher latitudes in a giant planet magnetosphere than you have for Jupiter, or for the Sun for that matter?

DR. STONE: Not that we have for Jupiter. Remember the Pioneer 11 had a rather highly inclined trajectory past Jupiter to return across the solar system to Saturn, but it will be a more inclined orbit than we have leaving Saturn with Voyager 2. Voyager 2 leaves Saturn in the ecliptic plane because it is going on to Uranus.

MR. PANAGAKOS: Are there any other questions. Oh, Pat Young?

MR. YOUNG: Brad, are you real confident on those orbits of those two satellites, or is it a possibility there has just been an error in calculating the orbits and they are not, indeed, coming that close to each other?

DR. SMITH: We are real certain.

MR. YOUNG: Any possible explanation how this thing could have happened so that you have the two whistling around there for how many ever centuries?

DR. SMITH: Well, I don't think that you really worry about two objects being in the same orbit or almost the same orbit. What you worry about is why don't they collide with one another and there is, in fact, a mechanism whereby one is approaching the other and when they get very close to one another, and I mean so close like they are a few diameters apart, then the leading one loses energy as they are attracted for one another.

The leading one loses energy. The following one gains energy. Now lower energy means you drop into a lower orbit. Gaining energy means you go into a higher orbit.

So they come up like this and exchange energy and turn around. And so they just go back and forth. That is one explanation.

MR. PANAGAKOS: Tom, did you have a question here?

MR. O'TOOLE: Brad, how many concentric features, have you counted them inside the A and B ring, you know, that you didn't see before?

DR. SMITH: No.

MR. O'TOOLE: You said there were dozens.

DR. SMITH: I can't because, Tom, every day there are more.

The plot that I showed you I think is perhaps now even two weeks old and as we get higher and higher resolution we are just seeing more and more.

MR. O'TOOLE: These are not --

DR. SMITH: No, it is structured within existing rings, but it becomes rather difficult now to really define these rings. These rings were defined by their albedo or ring A was separated from ring B by the Cassini Division. Well, the Cassini Division now has a bright ring in the middle of it and now the bright ring has a dark gap in the middle of it. So where is the boundary between the A and B ring?

MR. PANAGAKOS: A1?

MR. SEHLSTEDT: Dr. Smith, would you go over those statistics again on the two satellites please? Did you say their radius, did you say their radius is 250 and 300 kilometers?

DR. SMITH: No. You are talking about the two new ones that were discovered over the weekend?

No, these are not precise numbers. They are just the best that we could scale from the images in this short period of time. The outer most one has a radius of 142,000 kilometers. That puts it 2,000 kilometers outside of this very narrow F ring that was discovered by Pioneer.

The inner one, which is a bit smaller, the outer one we estimate to be about 300 kilometers in diameter, but that is based only on its brightness.

The inner one is probably more like 250 kilometers in diameter and it is about 500 kilometers inside the F ring. That puts it at about 139,500 kilometers. Again, these are just preliminary estimates of their radii.

MR. PANAGAKOS: Another question from Jon.

MR. EBERHART: Dr. Stone, is Rhea the first satellite on which Voyager has -- the first time that Voyager has used motion compensation for the photos? Is it the first time planetary spacecraft has and why on Rhea on this mission?

DR. STONE: I don't know that it is the first time. I guess I am not -- Viking has done a similar thing.

MR. EBERHART: Why only Rhea on this?

DR. STONE: Well, Brad, do you want to --

DR. SMITH: Well, Rhea is -- you pass close enough to Rhea and the lighting conditions are such that in order to realize all

of the potential resolution that we could get out of our cameras because of smear problems we have to do this image motion compensation. We don't have that problem elsewhere except at Titan. In Titan we come very close, as it said, and we have a severe smear problem there. Well, we are not doing anything about that; we will just take the smear.

DR. STONE: You will be looking at clouds.

MR. PANAGAKOS: Are there any other questions? Craig?

MR. COVAULT: Craig Covault for Aviation Week. Kind of an overall planetary question for Gus and I would also like to have the JPL types comment as well.

How would you compare the level of White House and Congressional support for planetary missions that NASA received seven to 10 years ago, which really produced missions like Viking and Voyager? How would you compare that to the kind of support you have received since the mid-1970s for planetary and how close is the U.S. to losing capability to mount big payoff missions like Voyager if the trend continues?

MR. GUASTAFERRO: Well, let me start. Let me say that I think Dr. Frosch said it correct in his article with your magazine on his departure, where he said the easy missions are behind us and the more complicated ones are ahead of us in terms of our switch from the inner planet to the outer planet strategy.

I guess I would like to remind the public that the planetary program has been supported on a sustaining basis. Our budget has been around \$200 million a year in terms of the research and analysis to support the indepth knowledge gained through missions like Viking and Voyager and Pioneer Venus and the Mariner series.

Now that is not a cop-out in terms of saying that it is enough. There is certainly more that could be done, but this administration, or the one before it, which set the policy of the events that we now face have not turned their back on the planetary program. It is now a shutdown program. It has been one that, in my judgment, has been metered back.

I think there are a couple of reasons for that. One is the agency took a position to develop the Shuttle as a transportation system that I think is the right thing to do because it is going to make the mission to the outer planets, missions in deep space, possible on a more convenient and more time scheduled basis. But once you take a thrust of developing a launch vehicle or a space transportation system of the size of Shuttle, and you are in sort of a fixed economy view relative to the overall agency budget, there is something that has to give in the system and I think the give is space science and, in particular, the planetary program.

So in a sense we see the start up of new programs slowed by

A, the economy that we are facing; B, the more complicated missions that we face; and C, the aspects of the agency developing a launch vehicle program.

I forecast a very positive future from where we sit. I think the NASA Administrator has selected to form a solar system exploration committee headed by Dr. John Naugle, and having membership like Noel Hinners, the past Associate Administrator for Space Science.

We will convene our first meeting at the Voyager encounter on Nov. 10th for the express purpose of looking at solar system exploration, planetary in particular, so it is the last 15 years of the century with the idea of capturing the imagination and the success of Voyager and to move out into a post Shuttle development period in a very positive way. I will ask my friend Andy to see if he wants to correct anything I said.

MR. STOFAN: No. I think Gus did it very well. We are in a slow down mode now, but it is due to the pressures of the budget and development of the Shuttle, which is the prime goal of the agency.

Space science is alive and well. We are healthy. And we are waiting to the post-Shuttle development area where we again go back with a very ambitious space science program, including the planetary program.

MR. PANAGAKOS: Is that okay?

MR. YOUNG: Can I follow on that?

MR. PANAGAKOS: Sure, Pat.

MR. YOUNG: I would like to hear from Brad, what is it -- we have got this large gap that is coming in and there is only one shot is approved in the mid-'80s, what is this going to do to our planetary science team that is going to assemble around the country and what are they going to do and have to work on over the next decade before we get much going again?

DR. SMITH: Well, there is the Galileo mission. There also, hopefully, will be encounters with Uranus and Neptune by Voyager 2. That will take us up to 1986, 1989. And there is, of course, the hope that we will get some sort of a new start for Venus.

But it does make it difficult, the problems of graduate students who will be the scientists to conduct the missions of the future and what their attitudes will be to pursuing careers in planetary science.

It is difficult to say what the impact is going to be, but it is clear that there will be some.

MR. PANAGAKOS: Jon?

MR. EBERHART: Brad, two things: would you expect the spacecraft to see or detect any hard link associating Enceladas and the E ring, like spreading out particles if you hit it just right, or whatever association?

DR. SMITH: Well, first of all I should say I think Ed mentioned that there was some controversy surrounding that. We also made observations. That is, we at Arizona had made observations of that same E ring with that same camera system. And I think perhaps our analysis is a little further along than the analysis that was done at Lowell Observatory and we do not find the peak at the orbit of Enceladas, but actually significant inside the orbit of Enceladas now.

That doesn't mean that there isn't a connection. The peak is not right at Enceladas itself.

MR. EBERHART: What kinds of consequences, apart from giving birth to an E ring, do you suppose might ensue from the kind of tidal interaction that Enceladas had been involved in?

DR. SMITH: Well, there are a couple of models. One is that you have an Io type effect going on with Enceladas and maybe it is squirting stuff out. Now the other that Ed Stone mentioned is the possibility of some impact. I don't know how recent it would have to be, because that would have to depend upon the size of the chunks that it threw out, but one can image it throwing out a large number of chunks which have been diffusing inward and outward over geological time scales.

MR. EBERHART: One other question. Do you have any data or reason to anticipate that Titan may turn out to have its own rings, or its own satellite, something? It seems to have everything else.

DR. SMITH: We asked some of the theorists whether Titan could have a ring and we got different responses. We decided the best thing to do is just look.

MR. EBERHART: Did you add in some photographs to look for possible signs of such things?

DR. SMITH: No, they did not. They have to be taken at about the time we are in the ring plane of Titan.

MR. PANAGAKOS: If there are no more questions then that concludes our briefing today. Thank you very much for coming.

(Whereupon, at 11:38 a.m. the briefing was concluded.)